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No. 27

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'SCIENCE AND TECHNOLOGY REVIEW'
First Issue on Sale

NATIONAL DEVELOPMENTS

STEPS TO MODERNIZING SCIENCE, TECHNOLOGY DETAILED

Beijing ZHEXUE YANJIU [PHILOSOPHICAL RESEARCH] in Chinese No 4,Apr 79 pp 11-20

[Article by Zhao Hongzhou [6392 4767 1558]: "An Attempt To Expound on the Problem of Modernizing Our Country's Science"]

[Text] What is the modernization of science? What standard must a nation's scientific undertaking reach before it can be considered as "modernized science?" How can "the modernization of science" be materialized? These are the questions which the people of the whole country, especially comrades in the scientific and technical circles are concerned about now. As the whole party is shifting its main line of work to the four modernizations, it is undoubtedly useful to discuss this problem.

The philosophy of science tells us that the speed at which a country's science is developed is determined not only by economic and political factors, but also by the scientific capacity of a country's society.[1] The scientific capacity of a society is composed of such factors as the contingent of scientists, experimental technical installation system, library information network system, scientific work structure, and scientific education system all organically combined into a kind of social force. As the product of the socialization of scientific work, the scientific capacity is a tremendous force behind the human effort to understand and remake nature. The fact that it can diffract light with sophisticated technique reflects the relationship between man and nature; and it falls within the domain of productive forces. Productive forces symbolize the productive level of a society, while scientific capacity symbolizes the scientific and technical level of a nation. This is precisely why the problem of "modernizing science" is actually the problem of modernizing scientific capacity. The scientific capacity of a society includes the following basic contents: (1) the group research capacity of the contingent of scientists; (2) the quality of experimental technical equipments; (3) the efficiency of library information network; (4) the optimum level of scientific work structure; (5) the level of scientific education of the whole nation. The modernization of the preceding factors are precisely the specific standards of modernized science, and constitute the chief tasks in the effort to modernize our country's science.

1. Construct a First Class Contingent of Scientists

Among the various factors of scientific capacity, the group research capability of the contingent of scientists is the most important one. Besides economic and political factors, the rise of any nation's science in history is, without exception, related to the training of a great contingent of top scientists. The contingent of scientists in the present age not only includes outstanding scientists, but also outstanding experimenters, engineers, professors, library information experts and science management experts, as well as the ranks of thousands upon thousands of mass scientific researchers. This contingent cannot do without professionals, i.e. it must have experts in mathematics, physics, chemistry, biology, etc. The only way to adapt to the development of natural science integration is to have a complete set of disciplines as well as fine division of work; moreover, everyone must exchange views and grow up together. This contingent cannot do without people, as it must form a social group, otherwise there is no way to organize large scale social coordination, and it would be impossible to create a collective force, which makes it impossible to push our nation's science into the forefront of the world. The statistical curves representing the number of major scientific research achievements and the number of outstanding scientists appearing in some 300 years in the contemporary era constitute strong proof of the fact that the preceding conclusion is based on facts. (See Figures 1 and 2)

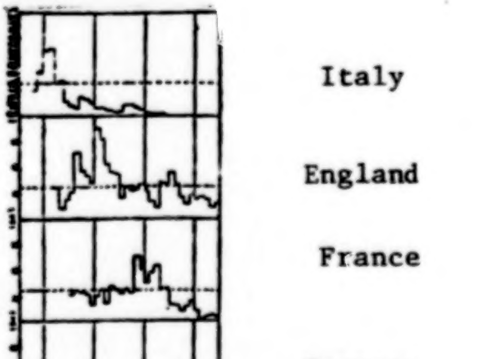


Figure 1. Number of Great Events in Various Countries as Against Total Number in the World

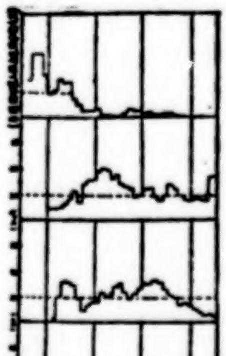


Figure 2. Number of Scientists in Various Countries as Against the Overall World Population

Based on "Annual Charts of Great Events in Natural Sciences"

From the figures, it can be seen that the peaks of both curves are basically congruent, which means that regardless which country it is, the times in which numerous scientific achievements were produced were the same as those in which talented people in science came forth in large numbers. This was true in Italy from 1540 through 1620, in England from 1660 through 1750, in France from 1760 through 1840, in Germany from 1840 through 1910, and in the United States from 1920 to the present. Conversely, if a nation's contingent of scientists is destroyed, the nation's scientific development may come to a standstill. The wave troughs in both figures are basically congruent, which also proves the point. Of course, the absolute number of scientists in the wave trough years of the 20th Century could very well be greater than the wave crest years of the 18th Century.[2] But it does not present an obstacle to the preceding conclusion, because as compared against the world's total figure, the percentage of scientists in countries who are at the center of the world's science is still the highest.

Table

Year Category	1600-1700	1700-1800	1800-1900	1900-1960	Total
Total number of outstanding scientists	48	103	396	682	1249
Number of multi-productive scientists	13	13	42	81	149
Percentage	27	13	11	11	12

The most noteworthy tendency of the present age is the daily declining ratio of multi-productive scientists (i.e. those who have made more than two major contributions in their lifetime). (See table) That is to say, in the present era, the overwhelming majority of outstanding scientists have only made one major contribution in their lifetime. The ratio decline of multi-productive scientists makes the group research capability of the contingent of scientists increasingly more important than ever. In the past, a famous scientist could produce several major research results on the average, or, at most ten-odd major contributions in his lifetime (such as Newton). Thus, if a country could train several master scientists of this caliber, it could surely cause its own science to move into the forefront of the world. But this will not work in the present age. Only a handful of outstanding master scientists is not enough; it is also necessary to have a contingent of brilliant scientists. Although the contingent may not have many outstanding multi-productive scientists, as long as it has a large number of outstanding monoproductive scientists, it can offset the inferiority caused by the decline of multi-productive scientists with the superiority in quantity. The large number of scientists coordinate with each other, thus forming a great group research capacity, which can often produce a great speed that is beyond the comparison of any age in history.

Thus, to increase the number of major scientific achievements, modern scientific work relies more and more heavily on the increasing number of scientists, and, unlike the past, it no longer depends on the multiple contributions of highly productive scientists. This shows that the number of scientists in a contingent is the basis of scientific research capacity in modern society.

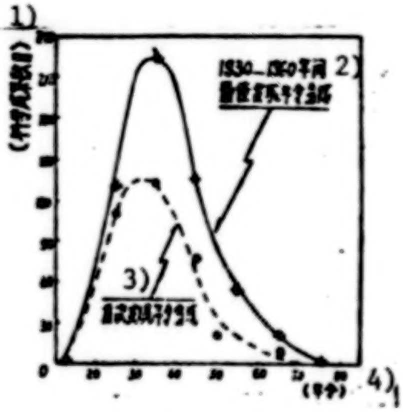
The contingent of scientists should not only reach a certain quantity, but also a certain quality. Besides a proportional number of advanced scientific researchers, the question of quality also involves another very important problem: the social age of the contingent of scientists (including the average age, optimum age and age spectrum).

The history of modern science shows that regardless of which nation, the average age of outstanding scientists in the overtaking stage and early rising stage of science is not over 50 years. In 1530-1570, before Italy rose to the center of science, the average age of its scientists ranged from 30 to 45. In 1640-1680, when England was on the eve of becoming the center of science, the average age was 38-45. In France, it was 43-50 in 1760-1800, and, in Germany, it was 41-45 in 1780-1840. But once the average age of noteworthy scientists exceeds 50, it could become a factor leading to the decline of science. In the 19th Century, the "extraordinary aging" of prominent scientists became a very important cause behind the decline of France's science.[3] In the years (1760-1800) when the average age of France's outstanding scientists was under 50, its scientists produced 35 percent of the world's total number of major scientific achievements. As its sky of science was filled with clusters of bright and shining stars, France became the center of world science. In 1800, as its average age exceeded 50, France's science passed its zenith years and began going down hill; and as the "extraordinary aging" occurred in 1850-1860, France's science had already fallen to the bottom of the trough.

The reason why a country's scientific undertaking is so affected by the average aging of its scientists lies in the fact that scientific work is both creative and complicated. This type of work demands greater human creative power and subjective initiative than any other kind of material productive work.

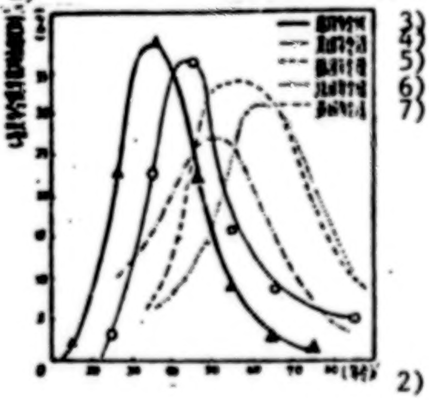
Generally speaking, the creative power of man is related to the extent of his practical experience and range of knowledge. But the accumulation of practical experience and knowledge is related to man's age. Based on the concept of physiology, a person's memory starts to wane (after a certain age) with his increasing age; but a person's faculty of understanding grows with increasing age. Thus, the best years of a person's creative power is when his memory has not failed and his comprehension capability is strong. This is when he is full of vigor and has rich practical experiences, a wide range of knowledge, plus a lot of imagination. He not only can take on large quantities of materials, but also dares to think and speak, and blaze a new trail. Thus, this is the time when the possibility of making contributions is the greatest. In the philosophy of science, it is known as the "optimum age zone" of scientific discovery.

Different persons, or different nations have different "optimum age zones." But taking the average situation of the whole world, under certain historical conditions, it is a constant (Figure 3). For instance, in the modern age, the optimum age zone of scientific discovery of outstanding scientists throughout the whole world is 25-45, and the peak age is approximately 36. The peak age at which one makes a breakthrough and becomes famous for his very first major contribution is about 32.



Key:
1) Number of scientific achievements
2) 1930-1960 optimum age of discovery curve
3) First discovery age curve
4) Age

Figure 3. Based on "Annual Charts of Great Events in Natural Sciences"



Key:
1) Proportion of results achieved by various age spectrums
2) Age
3) Optimum age curve
4) U.S. age spectrum
5) German age spectrum
6) French age spectrum
7) British age spectrum

Figure 4. Age spectrum curves of noteworthy scientists of various countries in 1950 compared against the current curve of the optimum age for scientific discoveries (Based on "Annual Charts of Great Events in Natural Sciences")

Thus, while other material conditions remain the same, if there is a guarantee that the great majority of people in a country falls within the optimum age zone of scientific discovery, there is no doubt that the country's contingent of scientists can gain superiority in scientific discovery. For example, in 1950, among the Western countries, the contingent of scientists in the United States was superior (see Figure 4). The figure shows that the age spectrum curve of the contingent of outstanding scientists in the United States was relatively close to the optimum age zone of scientific discovery at the time. The coincident area of the two curves is fairly large. It indicates that a relatively large number of outstanding U.S. scientists fell within the optimum age zone. In contradistinction, as the age spectrums of the contingents of scientists in Germany, France and England were way off the optimum age curve, they lost supremacy in scientific discovery, and consequently, up to now the United States is still at the center of world science.

The main reason why both the quantity and quality of the contingent of scientists can contribute toward the supremacy of scientific discovery lies in the fact that scientific groups with relatively high creative power have developed group research capabilities that are greater than the research capability of any individual. However, group research capacity is not tantamount to the simple stacking of the research capabilities of individuals. Instead, it is a "high powered magnification" of the research capacity of individuals. The group research capacity can greatly enhance the research capability of individuals. The group research capacity is essentially a social force formulated by the coordinative efforts in scientific work; like a new natural force generated by the social structure of material production, it can offer a great deal at virtually no cost to the society, which is immensely profitable. Thus, the group research capacity of the contingent of outstanding scientists is the chief factor of the society's scientific capacity. In the present age, when any country wants to develop its own scientific capacity and surpass the world's advanced level, it must first of all build a contingent of outstanding scientists. The contingent should be large scale and of high quality; the average age of brilliant scientists should not exceed 45 (the upper bound of the optimum age zone), and there should be guarantee that the age composition of outstanding scientists does not deviate from the current period's optimum age zone (25-45). Broadly speaking, this objective is one of the standards of the modernization of science in the present era, and if our country wants to realize the modernization of its science and technology, undoubtedly it should advance toward this objective.

At present, with the lofty ambition of "an old steed in the stable still bent on galloping a thousand li," the elder scientists of our country are striving hard to modernize our country's science. They are much treasured by the people of our country. In their prime and full of sap, our country's middle-aged scientists are shouldering the great task of inheriting from the past and opening up the future, and storming the citadel of science under the instruction of elder generation scientists. They are the backbone of our country's scientific and technical front. But it should also be seen that at present our country's contingent of scientists actually has no successors to carry on, and the social age is ascending. This kind of situation is extremely detrimental to the cause of surpassing the world's level. Thus, we must resolve to vigorously develop education (including "reeducation," cf.[4]), and change the qualitative structure of our country's contingent of scientists. With a first class contingent of outstanding scientists of the present generation, the society will have no advanced level scientific capacity to speak of, nor will there be the scientific capacity for modernization, and the modernization of our country's science will become empty words. Thus, the construction of the world's top ranking contingent of scientists and enhancing the group research capacity of our country's contingent of scientists constitute the first and foremost task in materializing the modernization of our country's science.

2. Build the Most Advanced Experimental Technical Equipment of the Present Age

As Marx said, scientific work is a "special mode of production."[5] Experimental technical equipment is precisely special work tools for this special kind of production. Together with library information materials, it constitutes the means of scientific work.

Experimental technical equipment is numerous and assorted; it mainly includes instruments, meters, machinery, materials, various types of agents (reagents, solvents, catalytic agents, etc), power and water/gas resources, as well as corresponding buildings and facilities. This all constitutes the material basis for scientific research. It can provide work objects for scientific work; by artificially reproducing natural phenomena in special environments, it is possible to study the properties of substances under special conditions and thus discover laws of nature which cannot be discovered in the struggle for production. It can provide scientific work with every possible means and tools of research; by eliminating secondary factors of natural phenomena and giving prominence to the main phenomena, it is possible to make precise measurements of single parameters and gradually grasp the essence of natural phenomena. Besides, by providing scientific research with all kinds of ingenious experimental methods (such as computer simulation, spectral analysis, bioengineering, chemical analysis, radiological observation, etc), the equipment can reproduce thousands of rarely witnessed natural phenomena in labs; within a few days it can reproduce thousands of years of evolutionary process: it can also artificially link up certain phenomena which seldom associate with each other in the natural world; with a set goal, it can induce phenomena which are normally concealed in the world of nature. It can even produce in labs certain organic substances which do not naturally exist in nature. In a word, as scientific experimentation became separated from production, experimental technical equipment thus became the material basis for an independent social practice.

What merits pointing out is the fact that since experimental technical equipment is a means of scientific work in the form of matter, it often acts as an indicator which shows the scientific capacity level of different countries in different ages.

Prior to the Industrial Revolution, experimental research equipment was in the stage of simple observation instrumentation. The capacity and wealth of a single person was sufficient to produce such instruments as Galileo's astronomical telescope. A scientist could engage himself in independent individual work. At that time, the society's scientific capacity was quite low.

Following the Industrial Revolution, experimental research equipment developed very rapidly. The society began to use geometrical measurement instruments such as plotters; measurement instruments for mechanics such as vibration instruments and gyroscopes; optical instruments such as microscopes, spectroscopes and telescopes; heat engineering instruments such as pressure gages, thermometers, flowmeters; and electromagnetic instruments such as electric current meters, voltage meters and power meters. As such instruments can make precise measurements of one kind of parameter, they are known as "single parameter" analytical instruments. As compared with observation instruments, the analytical instruments undoubtedly represent a kind of progress. It is the second stage of the development of experimental technical equipment. For the first time, "single parameter" analytical instruments have enabled scientific experimentation to "observe natural processes in places that are most reliable and least disturbed in the natural process, or, if possible experimentation under conditions which ensure the process and its pure state."[6] Thus, analytical instruments have greatly promoted the development of precision science and enhanced the society's scientific capacity.

In the first 30 years of the 20th Century, modern science developed at a pace that was beyond the comparison of any period in history. The objects of modern science research ranged from tiny spaces measuring 10^{-13} centimeters to vast and empty cosmic space some 10 billion lightyears in dimension. There are all kinds of complex intertwined phenomena in the world of nature. In order to measure more than two parameters simultaneously, get a picture of the instantaneous status of the natural phenomena, and obtain final results immediately, experiments now generally require extremely high speed and extremely high degrees of precision. Thus, electronic computers have become the ideal tool. With online computers, it is possible to combine many "single parameters" into an automatically controlled instrument system in which outside signals are first picked up by "single parameter" instruments; without manual control, the signals are directly fed into the computer; and, in the end, the computer yields the final results to the experimenter. Resonance probing systems in space science are all typical examples. Such complex experimental technical equipment is also known as "secondary probing instruments" because the type of results they produce are not the same as data produced by the "single parameter" instruments which carry out primary measurements. "Secondary probing instruments" constitute the third stage of experimental technical equipment. Thus, both the efficiency of scientific research and the scale of scientific work have made a tremendous leap forward. Twenty years ago, the bubble chamber experiments in high energy physics analyzed negatives manually, and each person could only do 1,000 comparisons each year. But with computerized automatic processing, each person can do 120,000 each year, thus increasing efficiency over 100 times. With the development of "secondary probing instruments," and the improvement of experimenting methods, some experiments which could not be performed in the past have also begun to be realized.[7]

Evidently, the quality of experimental technical equipment is the main component of the society's scientific capacity. [Experimental technical equipment] is the main tool of scientific work. Without it, scientific research would be just as helpless as mineral exploration without drills.

As the level of our country's experimental technical equipment is low to begin with, plus the sabotage by Lin Biao and the "gang of four," the vast majority of instruments now are outdated. There is not only a serious shortage of "secondary probing instruments," but even our "single parameter" analytical instruments are incomplete, inaccurate and unstable. Moreover, some of our instruments are still in the stage of observation instrumentation, and are manufactured totally by hand. This has gravely affected the development of our country's science and technology. Thus, to enhance our country's scientific capacity, it is imperative to greatly develop complex experimental technical systems consisting mainly of "secondary probing instruments," and the key to this lies in electronic computers. Without millions of various types of electronic computers, and without "single parameter" instruments which have high precision, good sensitivity, great reliability and excellent stability, our country's experimental technical equipment cannot be modernized and there is no way to improve the efficiency of our country's scientific work. Even if we have a first-rate contingent of scientists, our scientific capacity cannot be improved. Apparently, to build modernized experimental technical equipment systems composed mainly of "secondary probing instruments" is the second chief task in the current effort to modernize our country's science.

3. Establish Modernized 'Library-Information' Network Systems

Marx has said that scientific work is ordinary work of society. In this kind of work, "some requires coordination among contemporaries, and some requires the utilization of the work of predecessors."[8] "The work of predecessors" mentioned by Marx precisely refers to the scientific knowledge found in library materials. One special form of "coordination among contemporaries" is library and information work. Scientific work can never do without books, information materials and information work for a single moment. If we liken experimental technical equipment to the backbone of scientific work materials, then library and information would be the two wings of scientific work materials. Without its two wings, a bird can never fly.

In the 1960's of the 20th Century, the socialization of scientific work became greater and greater, and the specialization of science and technology became more and more elaborate. At the same time, the high level of specialization also led to high level of integration, which gave birth to frontier science and integrated science. Frontier science and integrated science have caused the contents of science to become complex and interwoven. One kind of magazine often contains four or five different subjects. When a scientist conducts research on some specialized problem, at least over one half of his materials are obtained by searching through other disciplinary magazines. In other words, in scientific work, one third of a person's energy is usually spent on investigation and study, which gravely affects the efficiency of scientific research.

On the other hand, with the growth of the publishing industry, the number of scientific materials is increasing sharply. In the early 1970's, 500,000 books on various scientific and technical subjects, some 40,000 scientific periodicals, 3 million scientific and technical papers, as well as all sorts of conference documents, study reports, patent documents and government publications were published each year throughout the whole world. How can a single person, or even a library, ever procure a complete collection of such a tremendous volume of scientific material with numerous and humbled contents? Thus, there is an interlibrary and international system for ordering and exchanging large volumes of scientific materials. Without such an extensive book and information exchange system, scientists cannot procure their scientific reference materials in time.

Thus, modernized scientific work has presented the society with the vital problem of whether or not to establish a modernized library information network system. A modernized scientific information system is an important means of improving the utilization ratio of publications and the efficiency of scientific research. The efficiency of library information is of direct consequence to the scientific capacity of a country. High efficiency virtually causes the current contingents of scientists to expand several times over, while low efficiency is tantamount to greatly reducing the contingent of scientists. This principle is quite obvious. It shows that the efficiency of "library information" system should be considered as a major factor of scientific capacity. It also shows that the third great task in materializing the modernization of our country's science consists of: automation of information retrieval and library management with the use of computer technology; store books, information and reference materials on microfilm through the application of optical recording technique; establish data transmission networks with the help of modern telecommunication techniques; set up a modernized "library information" system in our country.

4. Enhance the Optimum Level of Our Country's Scientific Work Structure

Scientific work structure is a component of scientific capacity. This is because the quality of the structure directly affects the scale and efficacy of social coordination, and social coordination often gives rise to new forces which enables society to profit enormously at virtually no cost. Just as Marx said: "Although the ordinary productive forces produced in the entire social production bottom structure is the product of history, it is also a natural gift from social labor."[9]

The first kind of work structure is the learned society. In the 17th Century, the growth of capitalist production greatly promoted the vigorous development of natural sciences. As production imposed greater and greater demands on science, the complexity of scientific work became greater and greater. It was very difficult for an individual not to rely on others and independently complete a major scientific invention and creation. For instance, Newton, the famous master of physics, could not have completed his computation of the universal gravitation without the help of the precise figure of the earth's radius which had been found by the French astroner [Jean] Picard. Scientific work needs the coordination of learned societies very much. In the mid-17th Century, scientific organizations similar to societies appeared widely in Western Europe. The Italian Accademia dei Lincei and Accademia del Cimento, the British "Invisible College" (i.e. the predecessor of the Royal Society), the French Pasal "Private Society" and the Academie des Sciences, etc all emerged to meet the demands. In such a work structure, the scientists worked individually. But, within the societies, the scientists coordinated with one another. Through the publications and conference correspondences of the societies, they could exchange ideas, enliven academic [life], discuss with one another, and improve together. Apparently, the society-type scientific work structure was a reflection in the realm of mental production manifesting the simple coordination of the realm of material production.

In the 18th and 19th centuries, scientific work improved remarkably both in scale and complexity. Scientific work began to develop toward specialization. In order to adapt to the characteristics of modern science and improve the efficiency of scientific research to the maximum level, specialized research organizations appeared in society. Typical among which were the Cavendish Laboratory in England (1871), the Leipzig Chemistry Laboratory in Germany (1875), and Edison Laboratory in the United States (1876). The first one is representative of basic science, the middle one represents applied science, and the last one is a typical scientific work structure in science and technology. Such research organizations were not so comprehensive as the British Royal Society. They were specialized research organizations dealing with one particular branch of science (such as nuclear physics, organic chemistry or electrical engineering); moreover, the scientists often worked collectively, each being assigned to a certain task in the overall scientific research project. But the collectives were not so free as the British Royal Society since they were bound by the direct coordination of scientists groups, just like handicraft workshops in material production. As this type of scientific work structure could make full use of "single parameter" analytical lab equipment, it could bring the initiative of specialized scientists into play. Thus, (at that time), it was an efficient work structure for completing those large scale and fairly specialized research projects at relatively high speed. For example, the great achievements attained by the Cavendish Laboratory such as the establishment of the electromagnetic wave theory, the discovery of the electron, and nuclear physics, proved the superiority of this kind of specialized work structure.

In the mid-20th Century, modern scientific experimentation became increasingly larger in scale, and entailed more and more investments as well, which caused individual specialized research organizations to fall very far behind. The only way out was to bring into play the economic strength of the whole country. For instance, in modern high energy experiments, the accelerators use up tremendous amounts of energy, the secondary probing instruments are extremely sophisticated, the technical links are divided very elaborately, and immense volumes of data collecting and processing are involved. Each and every piece of equipment requires monitoring and maintenance by special personnel. No work can be achieved if such a large scale contingent lacks experts in any single aspect. Thus, it is imperative to concert the efforts of experts in physics, chemistry, radio, electronics, semiconductor, computers, etc. In this kind of scientific work structure, all personnel and equipment must share the work and coordinate with one another. Besides specific division of work and strict demands imposed on various posts and positions, it is also characterized by uniform measures, full coordination, and intensive planning. Thus, it is very like the "reprint of the great machinery industry" in the realm of mental production, i.e. scientific work structure on "state scale." Today, both the U.S. National Aeronautics and Space Administration and the European Joint Center of Nuclear Research fall within this category.

A scientific work structure on state scale is essentially a kind of integrated work structure, which is the negation of the history of specialized scientific work structures, and also the negation of learned society type work structures. In the learned society stage, the integration of scientific work was manifested in the "freedom" of scientists in various periods to carry out individual work in various projects. But during the state-scale stage, the integration of scientific work was manifested in the "planned" collective work in various projects by scientists groups in different periods. Thus, the state-scale scientific work structure is an advanced stage as compared with the society-type structure. If the first stage is likened to simple coordination, then the subsequent stage is the complex coordination and advanced coordination of scientific work. The scientific capacity of the society produced by this type of advanced coordination is much greater than simple coordination. It often brings the society a tremendous amount of profit, and greatly enhances the society scientific capacity.

It can thus be seen that the historical evolution of scientific work structure was the inevitable result of the pursuit for its enormous natural tributes. Under different historical conditions, owing to the difference in the research capacity of scientists, plus the difference in experimental technical equipment and library information efficacy, the structures of scientific work also varied. In other words, in order to improve the efficiency of scientific work, it is necessary to give full scope to the initiative of human and material resources; besides political-ideological work, it is imperative to constantly change the structure of scientific work so as to give more scope to the various factors of scientific capacity. "Science management," which appeared in the 1960's of the current century, is essentially the science of how to build the optimum structure of scientific work, and how to obtain maximum scientific research efficiency.

Science management tells us that the social structure of modern scientific work is complicated but with regular pattern. It includes the social composition of the contingents of scientists, the social composition of experimental research equipment, the social structure of library information systems, the organic structure of scientific expenditures, the social structure of scientific research organization systems, etc. These structures are mutually causal; they are interlocked and form a complex spacial structure of modern scientific work.

The social structure of modern scientific work is also the function of time. It changes with the variation of conditions, and has distinct "flexibility." First, the contingents of scientists are characterized by mobility. They often shift from one "front" to another to meet the demands of the society as well as the interest of the individual. They must continuously undergo the process of metabolism to adapt to the capabilities of the individuals and their social ages. Second, experimental technical equipment systems can be converted. The "single parameter" instruments are constantly recombined according to different problems, and the online systems of the computers go through frequent conversions to meet different tasks. Third, library information systems can conduct exchanges. To meet the needs of scientific research, the mode of storing books and materials must be constantly changed. The information materials must be constantly updated to meet the needs of the users.

Fourth, there is flexibility in scientific expenditures. Based on different situations, the proportions of various capital investments are often adjusted, and the funding recipients are continuously altered in consideration of economic results. Fifth, owing to the four reasons cited above, the organizational system of scientific research naturally should have a certain degree of mobility. The divisions and groups are often "mounted" or "dismounted" in accordance with the development of various problems, and the scale is often enlarged or reduced in accordance with the society's needs. Thus, both in terms of space and time, the social structure of scientific work manifests itself as an extremely complicated social function. In the wake of the 1960's, "scientific research centers" or "flexible research institutes" emerged extensively around the world, which, in fact, was the concrete reflection of the preceding characteristics.[10] Thus, in modernized science management, efforts must be made in studying the "management of developments," i.e. to regulate personnel, equipment, books, funds and the structures of divisions and groups in a planned and scientific manner (including the use of such sciences and technologies as system engineering and electronic computers) in accordance with the law of movements in scientific research and specific historical conditions so as to attain maximum efficiency in scientific work.

Facts show that the quality of a country's scientific work structure, and the level of its science management greatly affects the nation's scientific capacity. Good quality work structure means the maximum utilization of human and material resources. When the work structure is poor, there is a lot of mutual wrangling over trifles and enormous "internal waste." It is useless to increase capital investments. One of the main reasons why U.S. science and technology grew at a rapid pace after World War II was the "maturing of experiences in science management work."11 Evidently, the optimization of scientific work structures constitutes a major factor of a country's scientific capacity, and imposes an important task in the modernization of a country's science.

This is why it is imperative to realize the transition from "static administration" to "dynamic administration" in science management. There should be mobility and metabolism in the contingent of scientists. Experimental technical equipments should be exchanged and employed through proper implementation of centralized management and leasing system. There should be an integrated system for publications and information, which can facilitate mutual exchanges among the personnel, and the sharing of reference materials. Flexibility should be exercised in scientific research budgeting, allowing university research organizations to apply for funds from state-owned scientific research institutions, and also allowing civilian research to apply for funds from military departments and undertake military research projects. Efforts should be made to constantly balance the various proportions of scientific investments among all divisions and systems, and make maximum use of the state's limited funds for scientific research. There should be a certain degree of "flexibility" in scientific research organizations; divisions and groups should be frequently recombined as scientific research projects are altered, thus preventing the aging of organizations. In a word, it is necessary to reform the current scientific work structures in our country, enforce "dynamic management" of modernized science, constantly improve the optimum level of our country's scientific work structure, and gradually improve our country's scientific research efficiency. This is the fourth major task in realizing the modernization of our country's science.

5. Improve the Science Educational Level of the Entire Nation

Science education is at once the product of modern history and the cradle of modern science. With the vigorous development of science and technology, science education has continuously grown in scale; its level has continuously improved; and, objectively, it has become a potential scientific capacity. With science education, it is possible to realize the "reproduction" of scientific capacity, and thus enable the contingent of scientists to thrive and flourish, and have successors to carry on. With science education, it is also possible to further enhance the research capabilities of scientists, and change the quality composition of the contingent of scientists. Moreover, with science education, it is possible to help large numbers of youths to join the ranks of scientists in advance, which prevents the "extraordinary aging" of the social ages of scientists from occurring, thus creating scientific capacity of higher level.

The history of science shows that scientific work is extremely arduous and complicated brain work. The maximum length of a scientist's career in science may only last several decades, and his optimum age zone may only be ten-odd years. The answer to how to combine the limited research capacities of individuals into the immeasurable research capacity of the society lies in the intermediate link--science education. Science education is like an "education factory" in that it can "reproduce" each and every scientific research capability. It can supply the contingent of scientists with a steady stream of talented people, and thus forever maintain the huge and vigorous creative capacity of the contingent of scientists.

Science education can build up the contingent of scientists, improve the quality of the contingent of scientists, and change its quality composition. Generally speaking, a country's contingent of scientists is composed of advanced level, intermediate level and elementary level scientific researchers.

In a high quality contingent of scientists, advanced level scientific researchers occupy a relatively large proportion; in a low quality contingent of scientists, the proportion of advanced level scientific researchers is relatively small. Thus, the major task of "reeducation" is to try to expand the proportion of advanced level scientific researchers, and reduce the proportion of elementary level scientific researchers. For example, prior to World War II, the United States did not pay much attention to "reeducation." As "reeducation" received better attention following the 1950's, immense changes in the quality composition of America's contingent of scientists took place in the 1960's.[12] The improvement of the level of the contingent of scientists in the United States greatly promoted the development of science and technology. This was manifested by the actual continuous growth of the number of Nobel Prize winners among U.S. scientists. Within the span of 10 years from the 1950's to the 1960's, there were 51 Nobel Prize scientists in the whole world, 27 of whom (53 percent) were Americans. In the 1920's of the current century, the United States began to enter the center of world science. It was also attributed to science education. Evidently, science education has tremendous impact on the contingent of scientists.

Actually, based on the concept of dialectics, science education and scientific research are two inseparable aspects of scientific work. They are two different stages which are mutually related. Science education includes scientific research, and scientific research includes science education, which is like having scientific research organizations within universities, or having "reeducation" in science academies. Science education and scientific research are embodied in each other. As far as training talented people is concerned, science education is the root base, and scientific research is the flower. As far as the productive aspect of scientific knowledge is concerned, scientific research is the water source and science education is the stream. Scientific research is the higher stage of scientific work; science education is the dissemination stage of scientific work. The two stages are linked to each other, and they are closely related. If science education is not linked to scientific science education, then the contingent of scientists will have no successors to carry on. It will be impossible to pass on the results of scientific research to the successors, and there is no way for scientific research to obtain the practical applications of social production. Thus, the beautiful flower--scientific research--will wither away. Science education and scientific research are a unity of opposites. If the contingents of scientists, experimental equipment, library information, and work structures are all parts of scientific capacity, then science education also falls within the category of the scientific capacity of the society. The only difference lies in the fact that while the former is realistic and direct scientific capacity, the latter is potential and indirect scientific capacity. Thus, when any country wants to realize the modernization of its science, it should not fail to stress science education as a major task. The modernization of our country's science is no exception either.

At present, there is no scientific education system for "reeducation" in our country, which is certainly both distressing and sad. Simple computation indicates that owing to the sabotage by Lin Biao and the "gang of four," it will not be until 7 years later that our country's contingent of scientists can get a large-scale replenishment of newly emerging forces. This means that within these 7 years, the only way to expand the contingent of scientists is by "reeducating" approximately 1 million college students (including worker-peasant-soldier students) who graduated in 1961-1978. Hence, we must really stress "reeducation" and increase the proportion of college level students joining the ranks of scientists. Otherwise, the speed at which the modernization of science is being realized in our country will be affected.

In summing up the above, it is not difficult to arrive at the conclusion that the problem of modernizing the science of a country is essentially the problem of how to modernize the scientific capacity of the society. The basic contents of scientific capacity are the specific standards of scientific modernization. The specific criteria are as follows: First, there must be a contingent of scientists that is among the world's top list; second, there must be modernized experimental technical equipment consisting mainly of "secondary probing instruments"; third, there must be a modernized "books-information" network system; fourth, there must be an optimum scientific work structure; fifth, the scientific educational level of the whole nation must be greatly improved. The preceding five standards also constitute the five major tasks of realizing the modernization of science in our country. By advancing toward this goal, i.e. by advancing toward the modernization of science and completing the preceding five tasks, our country will surely be known as a "modernized scientific" country.

FOOTNOTES

1. The scientific capacity of a society is the capability of a nation to develop its science and technology. In foreign countries, it is known as "scientific potential," or "scientific force." Beginning in the 1960's, there have been heated discussions in foreign countries on the question of what scientific capacity contains. The author has already discussed the problem of the society's scientific capacity in the article "An Attempt To Expound on the Society's Scientific Capacity." Please refer to Red Flag, No 4, 1979.

2. According to Webster's statistical cards on personages, the number of scientists in different ages has progressively increased. From 1500 to 1900, the statistical figures of noteworthy scientists every 50 years are: 25, 34, 51, 56, 147, 308, 720, 810. (Cf. Webster's Biographical Dictionary (1951). A Dictionary of Names of Noteworthy Persons with Pronunciations.)

3. Japanese Studies in the History of Science, No 1 (1962) pp 57-75.

4. The so-called "reeducation" is the scientific education of the contingent of scientists. This type of education is higher than the level of higher education in general; it is more specialized, and it is designed to remake the qualitative make up of the contingent of scientists.

5. Marx: "Manuscript on Economics and Philosophy," People's Publishing House, 1957 Edition, p 83.

6. "Complete Collected Works of Marx and Engels," Vol 23, p 8.

7. For example, in high energy neutrino experiments, as neutrinos are weak action particles which contain no electricity, the cross section of action is extremely small, and a single free neutrino can penetrate through 1,000 Earth globes, which means that it is very difficult to capture. But with the help of "secondary instrument" systems, the probing technique has improved, and now the European nuclear center has collected 5 million illustrations.

8. "Complete Collected Works of Marx and Engels," Vol 25, p 120.

9. Marx: "Foundations of the Critizue of Political Economy (Rough draft)," 3rd Book, p 350.

10. Scientific research centers are chiefly national or international scientific research organizations funded by the state. They consist of staff members hired by the state, and a floating staff. As they attract scientists from the whole country and all over the world to participate and coordinate, the staff turnover is great. But the facilities basically do not change, and not many changes are made in research direction. They are suited to the characteristics of long-period basic scientific research projects as this type of structure enables the utilization of expensive experimental research equipments (such as accelerators) and facilitates academic exchanges. Flexible research institutes are research organizations composed of one kind of personnel, facilities and divisions/groups, and often undergo internal changes. Arguments for project proposals must be submitted, and the subordinating research personnel are invited by project leaders through public notices. Thus, there is competitiveness here. Such structures are especially suited to the realms of technical science and applied science as their research periods are relatively short and adaptable to alterations.

11. See China Scientific & Technical Information Institute: "Characteristics of the Development of Science and Technology in the Present Era," Part 4.

12. During this decade, the ratio of physicists with a BS degree among American scientists increased from 23 percent to 33 percent; the ratio of physicists with a PhD degree rose from 18 percent to 25 percent. Engineers with a bachelor's degree doubled, and those with a PhD degree tripled.

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NATIONAL DEVELOPMENTS

THEORETICAL PROBLEMS IN MODERNIZING SCIENCE, TECHNOLOGY DISCUSSED AT FORUM

Beijing ZHEXUE YANJIU [PHILOSOPHICAL RESEARCH] in Chinese No 4, Apr 79
pp 77-79

[Article by Wang Wei [3769 4850]: "Beijing Forum on the Theoretical Problems of the Modernization of Science and Technology"]

[Text] Acting in the spirit of the Party Central Committee Work Conference and the Third Plenary Session which calls for shifting our main attention to the construction of the four modernizations, on March 2, our editorial staff and the Dialectics of Nature Research Division of the Institute of Philosophy held a joint forum on theoretical problems concerning the modernization of science and technology. Attending the forum in Beijing were some 50 comrade workers specializing in science, philosophy and dialectics of nature. Comrade Yu Guangyuan [0060 0342 3104], vice president of the Chinese Academy of Social Sciences also participated in the forum and delivered a speech. There was a wide and lively discussion among the participating comrades on such problems as the law of developing modern science and technology, how to introduce foreign science and technology, the emancipation of the mind, and how to adapt the management of scientific research organizations to the four modernizations. Among the speakers at the forum (in the order of delivery of speeches) were Comrades Lei Tianjue [7191 1131 6030], Qian Weizhang [6929 0251 7022], Xi Zezong [1598 3419 1350], Zhang Guangdou [1728 0342 2435], Deng Yumin [6772 5940 3046], Yu Guangyuan [0060 0342 3104], Xu Kongshi [6079 1313 2514], Wu Mingyu [0702 2494 3842], Liu YuanZhang [0491 3293 1728], Yu Jingsheng [0151 2529 3932], Zheng Muqi [6774 1970 0366] and Li Peizhang [2621 3099 4545]. Following is a summary of the discussion:

I. On the Law of Developing Modern Science and Technology

In their speeches, some comrades pointed out that the development of modern science and technology is inseparably and closely related to the society's economy, culture and education. It is the product of the development of social economy, culture and education. Modern science and technology had to go through a certain process before it developed to the present level, it has its own laws of development. Today, while we are lagging behind other countries, we are striving to realize the modernization of science and technology before too long which is impossible to achieve without mastering the laws of development. Many problems have to be approached from the high plane of philosophy. Moreover, in practical work, it is necessary to advocate dialectics, oppose metaphysics, and observe the objective laws. This is the only way to attain our objective within a relatively short period of time and with relatively high speed.

The laws of modern science and technology development can be summed up in the following characteristics: (1) The relationships between science and technology, and between science/technology and production are becoming closer and closer. The great development of modern science and technology which began in the 1940's of the present century was based on the development of the basic theories of natural science in the 1920's. Thus, it is safe to assume that without the breakthroughs in scientific theories, there would have been no great development in technology today. Today, as we are realizing the modernization of science and technology, we cannot merely stress technology as it is imperative to fully understand how important basic research in scientific theory and natural sciences is to the development of technology. At the beginning of this century, the role of science and technology in the development of productive forces accounted for only 5 percent on the average, or at most not exceeding 20 percent. But now, it is over 60 to 80 percent. Therefore, science and technology are the key to the four modernizations. (2) It is imperative to have a strategic plan for the development of modern science and technology. Also, there must be foresightedness in scientific and technical research work. This is the general characteristic among scientifically and technically advanced countries in the world today. Sweden, England, the United States and Japan all have strategic policies and plans for developing their own science and technology. Moreover, most of them are employing the most advanced system engineering, and are conducting in-depth research on the development of science and technology. They are not totally divorced from planning as we used to think. We, on the other hand, lack very much in this aspect. With regard to the present, to a great extent, the key to successfully modernizing our country's science and technology lies in whether or not there are any strategic plans and concrete policies for developing our country's science and technology, and whether such plans and policies are suitable. (3) To develop modern science and technology, it is necessary to appropriately coordinate the relationship between basic research, applied research and development research. In foreign countries, the general proportion among the three is as follows: Approximately 10 percent for basic research, approximately 30 percent for application research, and about 60 percent for development research. Moreover, the three are very closely linked together. Owing to this type of coordination and proportion, the moment a new discovery has been made in basic research, it is possible to follow it up with application research and development research. Or, after introducing a new type of technology, it is possible to immediately "digest and absorb" it, and also to reproduce and develop it.

It is very worthwhile to learn from the experiences gained by foreign countries in this aspect. We must overcome the existing noncoordinative situation, strengthen basic research, improve application research and development research. (4) The modernization of science and technology can also be regarded as a flower blossomed from the development of social economy and social culture. Suitable social conditions are required to preserve and cultivate it. In order to correctly solve the numerous problems in our country today, we must develop democracy, seriously implement the policy of "let a hundred schools of thought contend" in scientific and technical research work, carry out the party's policies toward intellectuals, help scientific and technical workers to free their minds of various kinds of obstructions, and give full play to their initiative. Also, it is necessary to widely disseminate scientific and cultural knowledge among the Chinese people and help raise the level of the entire nation. In particular, it is necessary to spread scientific and technical knowledge among comrades currently in leading positions at all levels so that they may fully recognize the importance of scientific and technical work. This is the only way to develop our country's science and technology at a relatively fast pace, and realize the four modernizations soon.

II. Points To Take Note of When Importing Modern Science and Technology

In their speeches, some comrades pointed out the important significance of introducing technology under the special historical conditions prevailing in our country today. The special historical conditions were brought about by the long period of isolation of our country from the rest of the world, which gave rise to the present backward status. If we want to enter the world's mainstream of scientific and technical development, it is necessary to import [modern science and technology] in a planned way. Moreover, even when we reach the scientific and technical level of advanced countries in the future, we will still have to import [modern science and technology]. Development is impossible without mutual exchanges and learning in culture, science and technology.

On the question of "importation," many comrades also pointed out: (1) What is to be imported? It is imperative to plan out what to import first and what to import later. At present, every department wants to import technology in accordance with its own interest. But the state must make overall plans, take all factors into consideration, and make proper arrangements. This not only helps to make proper use of the limited funds in foreign currency by spending the money on where it is needed the most, but also helps to produce effective results from the imported technologies within a short span of time. (2) "Importation" must be combined with the specific conditions in our country. Due consideration must be given to the arrangement and utilization of our nation's resources, energy sources and manpower. It is also necessary to consider whether the importation is suitable to our country's own technologies. As to the question of substitutions, it is best not to import whatever can be substituted [at home]. We should conduct special study of such problems. Importation must be combined with the protection and development of domestic science and technology. Even though we are currently lagging behind in certain aspects, we can, nevertheless, catch up, provided we are given a certain amount of fostering and help. (3) In "importation," attention must be paid to "digestion" and "absorption" as well. The importation of any kind of advanced foreign science and technology is bound to fail if it is not properly "digested" or "absorbed." The key to the successful experiences in foreign countries lies mainly in the total attention given to "digestion" and "absorption" following importation. To neglect "digestion" and "absorption" and solely rely on the purchasing of technology and equipment can never work. (4) The relationship between importation and original creation through independence and keeping the initiative in one's own hands should be properly understood and treated dialectically. In the past, as a result of the sabotage by Lin Biao and the "gang of four," there was a tendency to blindly reject foreign things and refuse to import any advanced science and technology. But now we must be careful of another tendency in which importation is carried out without any consideration of the fact that our country's science and technology should have their own characteristics. (5) Importation and storing for the future use should be combined. We should look further ahead, and not just confine ourselves to the present few years; we should look ahead to 7, 8 or even 15 years from now. Without a long-range point of view, we are bound to suffer losses and always lag far behind other countries. (6) The relationship between importing the most advanced and developing basics. We should not merely focus on the most advanced technologies. It is difficult to realize the four modernizations by concentrating on several advanced sciences alone. Modern science and technology require the use of advanced automation and computer techniques. But they are also inseparable from basic techniques in agriculture, mining, electric power, energy sources, etc. If we neglect research on basic techniques and fail to provide certain agricultural products, natural resources and energy sources, the call for realizing the modernization of science and technology will amount to nothing but empty talk. (7) The problem of importing technology and training personnel. Now a lot of technical equipment has been imported, but there is a shortage of qualified personnel to manage or operate it, which has resulted in tremendous waste. Thus, we must step up the training of our country's own scientific and technical personnel. (8) The task of importing technology must not solely rest with the economic departments. It is imperative to recruit experts from the scientific and technical circles and listen to their advice. (9) Summarize historical lessons. After liberation, there have been several massive importations of technology. Although they have played a certain role, they have also resulted in grave lessons. We must also summarize such experiences and lessons with care.

III. In the Modernization of Our Country's Science and Technology, There Is Need To Greatly Emancipate the Mind and Break Through Certain Forbidden Zones

In their speeches, many comrades indicated that if China wants to realize the four modernizations, it is essential to do away with the spiritual shackles and emancipate the mind. The so-called spiritual shackles are formed by regarding wrong things which do not conform with the objective laws, i.e. things which do not belong to the truth, as correct things, and, moreover, clinging on to them tenaciously. This is how spiritual shackles and mental taboos are formed. During the Lin Biao and the "gang of four" period, both metaphysics and idealism were on the rampant. They created all sorts of spiritual shackles which not only hampered the thinking of people, but also confused the minds of people. Of course, in our work, we have also inadvertently caused ourselves to be shackled by violating the objective laws and raising unrealistic slogans which do not agree with dialectics. Thus, we should do away with spiritual shackles and greatly emancipate the mind.

In their speeches, many comrades felt that the status of "remnant fears, remnant poisonous ideas, remnant bitter feelings and remnant wounds" do not conform to the needs of the current situation. To eliminate such influences, it is imperative to help develop a scientific atmosphere that is practical and realistic, fully promote democracy, strengthen the socialist legal system, really (allow everyone to) "say all (they) know" and "not blame the one who speaks," thus creating a lively situation in which there is democracy as well as centralism.

Some comrades also indicated that to modernize our country's science and technology, it is necessary to eliminate the trammels and influences of remnant feudal ideas and handicraft small producer ideas. In many places, remnant feudal ideas are still quite on the rampant. Such things as to rest content with the present state of affairs, to have no desire to make improvements, to nitpick about new things, and to be slow at accepting new things are all manifestations of such ideas.

IV. Scientific Research Organizations and Management Work Should Adapt to the Needs of the Four Modernizations

Among the comrades who participated in the forum, it was widely pointed out in their speeches that this is one of the serious problems we face today which has not been properly solved. It is manifested in many aspects: (1) The leading cadres should start learning from scratch. They must learn and adapt themselves to the methods of managing modern science and technology, and understand the law of economy. (2) It is necessary to further implement the party's policies toward intellectuals and give full play to the initiative of the scientific and technical personnel. (3) Restructure and strengthen the system in the scientific and technical sector. (4) Some comrades suggest we should get together all those comrades who have the experience and expertise in management, and organize them into an advisory setup which can conduct in-depth study of universal problems so as to draw on collective wisdom and absorb all useful ideas. We must strive to develop systems engineering, give scope to the role of systems engineering in business management and scientific research organizations.

Besides presenting their suggestions on the preceding problems at the forum, the participating comrades also put forward manv demands on workers in philosophy and the dialectics of nature. Some comrades expressed hope that our country's social science workers can come up with precise interpretation of certain concepts and domains of modern science and technology so as to help overcome the confused state of mind among the people. Some comrades demanded that the philosophy workers break out of their old conventions by not confining themselves to the works of Marx and Lenin or Mao Zedong Thought when making annotations; they should boldly express their own ideas about all sorts of practical problems, and sum up philosophical principles from practice.

In their speeches, the comrades pointed out that the party had focused its main line of work on socialist modernization and construction, and that there is peace and unity throughout the country. This is a very important guarantee for the realization of the four modernizations. If we can use theories to clearly expound on the theoretical problems in materializing the modernization of science and technology and also to implement them in practice, then we will surely attain the great goal of realizing the four modernizations within this century.

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NATIONAL DEVELOPMENTS

SCIENCE, TECHNOLOGY SEEN KEY TO INCREASED PRODUCTION

Beijing BEIJING RIBAO in Chinese 27 Dec 79 p 1

[Article by BEIJING RIBAO commentator: "We Must Value Science, We Must Value Intellectuals"]

[Text] The key to implementation of the four modernizations lies in raising the cultural, scientific, and technical levels of our whole people. Without modern science and technology, where are modern industry, modern agriculture, and modern defense coming from? This argument seems clear and beyond doubt.

However, in real life, this argument has not been completely recognized by the people. Some people still cannot see, or fail to see fully, the uses of science and of those intellectuals who do scientific work. Because of this, in some areas scientific work has been relegated to a position of "important in speech, secondary in action, and unwanted in busy times." Comrade Mao Zedong proposed 40 years ago that "we must use natural science to understand nature, overcome nature and transform nature, to obtain freedom out of nature." Regrettably, many people seem not to have heard, or to have forgotten later, and in the end there was no conscientious implementation of it. Now is the time to resolve this problem from top to bottom, in both theory and practice. Today this paper carries a dispatch concerning the achievements of instructors from the Beijing Agricultural University in treating saline soil which is very persuasive in proving the usefulness of science and scientific workers, and is worth reading by everyone.

In China, the bias against science and technology is really too deep. And this is not to mention the fabrications of the "gang of four." In the history of China, although intellectuals have been considered the first of the "four peoples" for a long time, workers in technology and natural science have still been held in contempt by people. If they are not cursed for practicing "diabolical tricks and wicked crafts," they are dismissed as practicing "insignificant skills." After the liberation, our propaganda work was sometimes one-sided. For example, we emphasized the function of laboring people, emphasized the requirements of developing production as a moving force behind science, and emphasized that the sources of science lay in the practice of labor and production, all of which were of course correct. However, they were emphasized to an unsuitable degree, deprecating and even denying the functions of science and technology, and the functions of the intellectuals, which was incorrect. The practice of productive labor is a rich source of scientific knowledge, but if it is not put in order and processed through scientific methods and the mental labor of the intellectuals, it would be impossible to transform the dispersed bits of practical experience into science.

Let's talk about Zhangzhuang in Quzhou County. The peasants there have struggled against salinization for more than 2,000 years. They spent their blood, sweat, and tears, have experienced success, and have experienced failure, and have acquired rich firsthand material. Any scientific worker coming to this area could not accomplish anything unless he respected their experience, coordinated with them, and studied what they had done; of this there is not the slightest doubt. However, another thing of which there is not the slightest doubt is that scientific workers understand many things that peasants do not understand, their vision is a little more broad, not only are they able to see the origin and development of the movement of fresh water and brackish water, they can also study the lessons of experience in success and failure at this problem in other countries all over the world. They are competent in modern scientific instruments and various kinds of examination methods, and can correctly recognize the circumstances of material movements. What is more important is that their scientific theoretical knowledge can not only increase the masses experience in knowing the hows and not the whys, but is also able to see through a phenomenon to its essence, and give a penetrating recognition of the mutual relationships between things and the laws of their movements. The facts of Zhangzhuang explain eloquently that the valiant and industrious peasantry, with the new weapon of science, is like a tiger with wings. Having gone 2,000 years without winning a victory, they depended on the help of science and finally won, crossing over the "Yangtze River" at one step from productions of 100 catties per mu or 200 catties per mu. The area of saline land in China is relatively large. Just imagine what a great contribution it will be to the country if we spread their experience widely!

In a survey of recent world agricultural development, hundreds and thousands of efforts have been concentrated principally on the solution of two problems: one is the conservation of labor force, the other is to increase the production of agricultural crops. The former depends principally on the large-scale use of agricultural machinery, as well as raising the cultural and technical level of the laborers; the latter depends principally on advances in science and technology, and of course there must be a certain amount of investment. Many European and American nations needed labor force urgently in the process of their industrialization, and the amount of energy spent in mechanizing agriculture was astonishing. On an average, there are generally more than US$10,000 worth of mechanical equipment for every agricultural laborer, and in some cases this reaches more than US$50,000. Our country has a large population, and our foundation is poor, so the amount we are able to accumulate each year per member of the agricultural population is not more than 8 yuan, and it would be very difficult for us to travel this road very quickly. By contrast, it is much more worthwhile to invest more brainpower and raise the scientific and technical level: it is economical of money expenditures and production can be raised rapidly, the people's lives can be improved rapidly, and it provides the precondition for further mechanization.

The general condition of our agricultural production for the past several years has been very good. Grain harvests have exceeded the highest levels of history. There has also been a relative development of the breeding and planting of other varieties. The market has begun to loosen up. The principal thing that made all these accomplishments possible was that policy was on the mark, broke the ultra-leftist restrictions that shackled the development of production, and mobilized the activism of the peasantry behind the development of production. In a certain sense it could be said that what we are eating today is policy rice. There is still a great deal of potential in this area. We must conscientiously implement the two documents of the Party Central Committee with regard to agriculture, further mobilize the activism of the broad masses of peasants, further liberate their hands and feet, and let them suit measures to local conditions under the guidance of the state plan, like the eight immortals crossing the sea, each showing his special prowess, bringing still further thriving development to the five industries of agriculture, forestry, animal husbandry, subsidiary production, and aquatic products.

However, we must still see that if agriculture is to progress, it must still depend on science. If we do not raise the level of agricultural science, and do not extend the use of advanced agricultural science and technology, there will ultimately be a limit to the improvement of agricultural production. The existing level of production technology among the peasants is restricted in several ways, and before it has been fully developed, this contradiction may not be very evident in some areas. But after 2 or 3 years it will gradually become prominent. The peasants themselves may make increasing demands in this area. We should foresee this now, and do something about it beforehand. A breakthrough in a scientific or technical problem requires time for research; the nurturing of scientific and technical talent requires a relatively long period of time; if we are to extend the fruits of science and technology, we must also raise the cultural level of the people. As for raising the cultural level and spreading scientific knowledge in the rural areas, the time required is even longer. It will not do to put off digging the well until we get thirsty.

In the view of people in general, buying machinery, building buildings, laying out agricultural fields, etc, are seen as investment in production, whereas education, cultural work, and scientific research are seen as items of expenditure in which they are unwilling to put more money or which should be trimmed first when the state must reduce investments. This concept must really be changed. Education, culture, and scientific research are all indispensable to the development of modern production. Investment in this area will not only be ultimately recovered from production, it can also be effective in raising the production rate of labor and creating even larger profits. These are all money-making transactions, not money-losing transactions. This is an objective law, and whoever recognizes it a little earlier is the one who will succeed; whoever violates it will suffer the penalties in practice.

If we value science, we must value the intellectuals. In accordance with the party policy, we should advance the status of the intellectuals a little, fully develop their function, put them in positions where they belong, and improve their working conditions and living conditons. Doing this is certainly not creating any intellectual "privilege," nor is it fostering "cockiness" among the intellectuals, but is something with benefits for the requirements of the four modernizations, for the workers and peasants, and for the people of the whole country.

To better realize the scientific cultivation of the land, comrades on all levels who are responsible for leading the work must study a little modern agricultural science, a little soil science, a little biology, a little agricultural chemistry, etc. They must not always have the attitude, because they come from rural areas, that "who doesn't know about farming?" In fact, if they really open their eyes, they will know that there are really many, many things that we do not understand about modern agricultural learning. Many people who consider themselves insiders are really outsiders, or at best are only semi-insiders. Only by getting into it rapidly and making ourselves true insiders will we have the initiative and true leadership over the process of implementation of the four modernizations. Being content to be outsiders for a long time, we may make some inappropriate decisions in the course of the work, which may impede the rapid development of the four modernizations, and which may cause us to be eliminated by life. Of course, this is something we are unwilling to see. We are Communist Party people. The ultimate objective of all our work is to seek the benefit of the people. Now the welfare of the people requires that we strive to become insiders in all trades and professions. We have no reason for not doing this.

The era of "scorning technical work as of no consequence" must be brought to a close!

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APPLIED SCIENCES

PRESENT SITUATION AND TASK IN GEOTHERMAL RESEARCH IN CHINA

Beijing DIRE YANJIU LUNWENJI [COLLECTED PAPERS ON GEOTHERMAL RESEARCH] in China Nov 78 p 1-11

Geothermics is a young science that is developing vigorously. It is a fundamental theory of earth science. Geothermal studies generally include two fields: 1. Theoretically, geothermics explains the distribution of contemporary heat fields of the globe, the structure of heat in the upper mantle and crust and ancient geothermal conditions and history of heat of the earth. 2. In application, geothermal studies the patterns of distribution of geothermal resources, condition of formation and feasibility of their development and utilization. It also studies geothermal conditions in mining regions, forecasts geothermal conditions of the deep, studies the causes of heating and geological measures to prevent damage by heat in mines. It also studies the ancient geothermal conditions at the time of formation of various mineral resources. It provides a theoretical foundation for the predication of the distribution of minerals and serves as a geothermal indicator for the general survey and prospecting for useful minerals.

It is self evident that the theory and application of geothermics are closely tied together. For example, the search for geothermal resources must be based theoretically on the characteristics of the distribution of heat fields in large areas and the patterns of shifts of high temperature zones in the earth's crust in space and time. Again for example, classification of mines of high geothermal temperatures, prediction of geothermal temperatures at the deep parts of mines and prevention of heat damage at the bottom of mines must all be based on such theoretical geothermal studies as the interaction between the external heat of the sun's radiation and the internal heat of the earth and the various geological factors producing high geothermal temperatures. Conversely, deeper involvement in many actual problems has brought out a series of theoretical subjects which still need to be solved. For example, every country is paying a lot of attention to the development and utilization of the body of high energy igneous rocks and even the geothermal energy of volcanos. Besides a series of technical problems, a clear understanding must first be gained of the conditions of the body of igneous rocks of high temperatures (about 350°C) at the shallow parts of the crust (3 to 4 kilometers) and their pattern of distribution. This involves theoretical questions about the heat structure of the crust and the upper mantle and the distribution of radioactive heat sources of the crust. In studying ancient geothermal conditions during the formation of various mineral resources, there is even more need to revive the history of the development of heat in a region and this latter subject is directly related to questions of the conditions and the history of the internal heat of earth. All of these are sufficient to show that theoretical study of geothermics is the foundation of actual work, and actual work continues to enrich and expand the content of theoretical studies in geothermics and provides new topics of study.

Because our nation's work in the theoretical study of geothermics developed rather late and since the work is very important, it must be hastened to fill the void in our nation's study of geothermics in the hope that we may be able to catch up and gradually reach and surpass the world's advanced levels. For this, this article will discuss a few opinions and experiences learned in work concerning our nation's present situation and task in geothermal studies. The purpose is to offer a few commonplace remarks by way of introduction so that others may come up with valuable opinions and search for a greater, faster, better and more economical way for the development of our nation's geothermal studies together.

1. Characteristics of Our Nation's Geological Structure and Several Patterns of Distribution of Heat Fields

Our nation is geologically an extremely complex and colorful nation. Viewed from the positions of the continental structure, it borders the Pacific Ocean on the east and the tectonic activity belt on the west. The Pacific plate affects the entire continental China and especially the eastern mountain regions greatly. Our nation's province of Taiwan is situated exactly on the borderline of the plates. Present day crustal movements are strong and hot springs of high temperature are widely distributed on the island. The temperatures can reach a high of 140°C. Other manifestations of surface heat such as geysers and fumaroles are not uncommon. These and some other geological and geophysical phenomena that manifest tectonic activity such as live volcanos, seismic belts and orogenic zones form a typical sense of island arcs. Northward from Taiwan, the island arcs of Japan, the Kuril Islands and the Kamchatka Peninsula spread towards the NE. To the south, the Philippines, Papua New Guinea straight down to New Zealand are all regions of strong contemporary crustal movements and are also world famous geothermal regions.

Our nation borders the sea. Information regarding the warm currents of the Japan Sea is more complete. According to Japan's conclusive report on "The Earth's Crust and the Upper Mantle Plans" (12), the average value of the heat flow is 2.01 ± 0.38 microcalorie/centimeter^2 · second, and at the southern measuring point the value of the heat flow can reach as high as 5 microcalorie/centimeter^2 · second or more. Scattered information of the South Sea (11) indicates that the values of the heat flow and the temperatures are higher. All kinds of indications point to the possibility of the occurrence of a high heat flow in the Gulf of Bohai.

In the continental inland, better studies have been done in the heat fields of the North China region. According to actual information obtained in launching geothermal work in mines conducted jointly by our group and the departments of coal mining, metallurgy, petrochemical industry and geology, the temperature at a depth of 300 meters underground beneath the plains of north China is between 20°C and 25°C and the geothermal temperature gradient is mostly between 2°C and 3°C/100 meters. At a depth of 36 kilometers, the temperature at the Mohorovicic discontinuity is about 560°C. The average heat flow in the plains of north China is about 1.5 microcalorie/centimeter^2 · · second. Compared to a same unit of geological structure of the same type, it is higher in geothermal value, geothermal temperature gradient and heat flow. This is directly related to the increase in tectonic activity and the "activation" of the north China block of this area since the mesozoic and neozoic eras. The geological structure of the South China block includes crystaline bases and sedimentary layers which are far more complex than that of the north China block. During the active period of Yanshan, activity of magma and faulting were even more violent, forcefully incorporating large amounts of granite to form complex fault systems. Due to insufficient actual data, it is still difficult to pinpoint at present the entire view of the distribution of the heat field. But the surface heat, hot springs and gushing of hot water from many coal mines and mineral deposits in the south seem to indicate that they reflect a high temperature geothermal field.

Our nation's western regions are still affected by the Pacific plate to the east as well as by the Indian plate to the south. Their effects are most visible in the Himalayan Mountains. According to data of our academy's Qinghai-Xizang scientific surveys, geothermal resources in Xizang are very rich, as indicated by manifestations of high temperature surface heat such as boiling spring, hot springs, geysers, fumaroles, steaming pits, steaming ground surfaces, and eruptions of heated water into steam. At present, prospecting for resources for a geothermal power station is being conducted in the Yangbajing region north of Lhasa. The actually measured temperature at a depth of 64 meters in a shallow pit is 165°C. Geochemical calculations of standard temperatures indicate at a depth of 1000 meters, the temperature may reach 300°C. Everyone knows that the Himalayan Mountain belt is the Mediterranean tectonic activity belt. Heat flow measurements (10) of the eastern extensions of the Alps, the Carpathians and Caucasus Mountains indicate the above tectonic activity belts are all high heat flow zones. Judging by geological structure, degree of crustal movement and surface heat manifestations, the Himalayan Mountain belt may also be a high temperature and high heat flow belt.

Research results obtained by comrades Zhang Wenyou (1728 2429 0147) (1,2) et al in their study of our nation's continental crust indicates it is characterized mainly by block-fault tectonics, i.e., the entire continental crust of China consists of various fault blocks (Diagram 1) of different sizes fragmented by two groups of X shaped sheared fault systems (NNE, NNW; NEE, NWW) of different scale and different magnitudes. Fault blocks can be classified into three diferent types according to their age, activity and formation and morphological characteristics. There are blocks, bends and folds. The

The fault system of the fragmented blocks can be classified as block sutures, deep faults and basal faults according to the scale, depth and developmental characteristics. Recently, comrade Zhang Wenyou et al (4,5) further classified the fault system according to the depths of cutting through each tectonic layer as: lithosphere faults which cut through the entire lithosphere and reach the plastic part of the upper portion of the upper mantle; the crust faults which cut through the entire crust and reach the Mohorovicic discontinuity; the basal faults which cut through the entire upper part of the "granite stratum" and reach the Cambrian System. Cap rock faults which cut through the sedimentary cap rock and reach the top surface of basal metamorphic rock; and slide faults between strata of different depths. The deep slide faults accompany tectonic movements of huge ridge and depressions while the shallow slide faults are mostly related to folds. The borders of the different blocks described above are outlined by the distribution of surface heat fields. In the following, we have used the results of temperature surveys conducted by our group and fraternal units over the years along the Tan-Lu fault to explain this problem.

The Tancheng-Lujing fault which almost runs through our nation's entire eastern region and extends in a NNE direction is an active crustal fault that separates the entire crust and reaches the Mohorovicic discontinuity. The fault crosses the Gulf of Bohai from the Shandong Peninsula to the Liaodong Peninsula and splits into two branches near Shenyang. The branches separately extend to the Jixi and Hegang area. The geothermal temperature gradient at the Jianshanzi Mine of Shuangyashan neighboring the Jixi Coal Mine is 3.57°C/100 meters. The geothermal temperature gradient at the basin of coal deposits of the jurassic of the mesozoic in Liaoyuan on the fault is 3.42°C/100 meters. The geothermal temperature gradient at the basin of coal deposits of the tertiary in Fushun is as high as 4.57°/meters. The geothermal temperature gradient at the downthrown basin of coal deposits of the tertiary in Huang county in Shandong is 3.66°C/meters. The geothermal temperature gradient at the downthrown basin of the tertiary in Shuyang to the east of Xuzhou in the southern section also reaches 4.28°C/meters. The average geothermal temperature gradient 20 kilometers from the Tan-Lu fault on the west side of Luohe Iron Mine in Lujiang in Anhui province is about 4°C/100 meters. The temperature of the earth at a depth of 300 meters in the fault inside the borders of Shandong province is higher than the earth's temperature of neighboring areas by between 3°C and 5°C. There are also many hot springs along the entire fault. All of these indicate that the Tan-Lu fault is a high temperature belt.

The emergence of high geothermal temperatures along the Tan-Lu fault has a deep geological background. Our institute's geoelectromagnetic depth survey team conducted field surveys in Linqi in Shandong. The results show that the Mohorovicic discontinuity at that locality is at a depth of about 30 to 35 kilometers. The highly electrically conductive layer of the upper mantle or the partially molten plastic sphere is at a very high point, about 70 kilometers or so (Refer to the article "Geothermal Studies of Mines and Classifications of Types of Geothermal Temperatures," Diagram 11). This forces the substances of the partially molten zone in the plastic sphere of the upper mantle at the magnetic source to gush up from the deep and large faults. The heat source of the deep parts is thus directly brought to the shallow parts of the crust or out from the surface of the earth. The mesozoic and the neozoic which are widely distributed from south to north in the faults thus creep in and produce extrusive rocks. On the other hand, the "baking" effect of the high temperature plastic sphere (about 1500°C) found at the shallow parts of the upper mantle increases the mass that conducts thermal currents coming from the bottom of the crust and finally leads to the emergence of high geothermal temperatures in the fault.

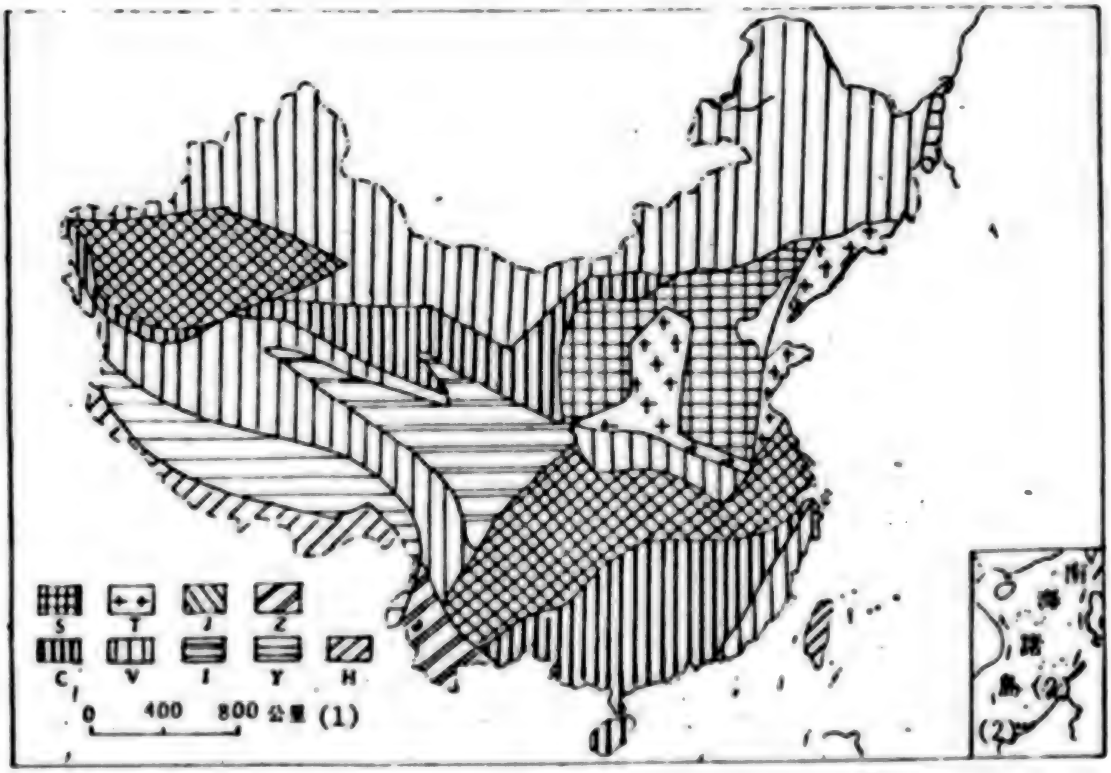

Diagram 1. Tectonic Profile of the Continent of China (Tectonics Drafting Group of the Geology Institute of the Chinese Academy of Sciences, 1974)
S. Sanggan Era T. Taihang Era J. Jinning Era Z. China Era
C. Jialidong Era V. Hualixi Era I. Indochina Era Y. Yanshan Era
H. Himalaya Era.

Key: (1) Kilometers (2) Islands of the South Sea

Several other kinds of fault systems are also manifested by the distribution of heat fields on the earth's surface. In 1974, our group discovered in the course of conducting temperature surveys in the Yanshou coal fields in southern Shandong province that the geothermal temperatures along the Yishan fault which cuts through the sedimentary cap rock is higher. At the same depth, the average geothermal temperatures of drilled holes in the fault is higher than that of drilled holes not in the fault by 2°C. This kind of actual examples are numerous in the north China regions. Our group discovered in the course of compiling geothermal temperature data of the North China plains that high temperature points often occur at the faults of cap rock of fragmented paleozoic blocks. Massive efforts of temperature surveys conducted in this country and in other countries have proven that faults of the lithosphere are actually locations of high geothermal temperatures and high heat flow along the borders of the blocks. Actual measurements of geothermal temperatures of basal faults and slide faults between strata are still lacking at present, but analysis of the mechanism of the formation of geothermal fields in the faults indicates that barring interference from other factors, high geothermal temperatures from these should also occur.

Because of the differential motion in the formation and the course of morphological change of the inner parts of fault blocks, the depths of the crystalline bases vary. For example, the ancient crystalline base of the Hebei-Shandong Block surrounded by the four crustal faults of the Tan-Lu fault, the eastern foot of Taihangshan and Qinling-Dabeishan's northern foot is uneven. This kind of uneven crystalline base greatly affects the distribution of the heat fields of the earth's surface. Speaking in simple terms, the geothermal temperature at places where the base is raised is high, and conversely, it is low at places where the base is low (Refer to article "Heat Flow of Earth in Northern China," Diagram 8). There are two reasons causing such distribution patterns of this type of heat fields: Analysis of the heat source indicates the content of radioactive elements in the crystalline base composed of magmatic rock and metamorphic rock is higher than ordinary sedimentary cap rock. On the same level, the localities where the base is raised may possibly provide more added heat source. On the other hand, thermal conductivity of the earth from the ancient crystalline base to the dense rock layer is better than that of the low density sedimentary cap rock layer. The two may vary by onefold. This makes it possible for more angular heat currents to concentrate at the localities where the base is raised. This kind of distribution of heat fields according to a pattern as described above caused by the differences in thermal physical properties and the differences in heat source is also valid for anticlimes and synclines of the smallest category of tectonic units. Recently, some people (9) have also used the computer to make quantitative determinations by mathematical simulation. Our group obtained similarly good results from calculations of geothermal fields by mathematical simulation using actual data of the Pingdingshan mining region.

In summary, although our nation's geological structure has many characteristics, there are two worth mentioning from the point of view of geothermal studies: One is that the nature of block tectonics of the crust underlying China is clearly reflected by the distribution of heat fields on the surface. Whether inside the fault blocks or along the border, the distribution of heat fields of fault systems of different scales and different categories and magnitudes have their own characteristic and pattern. The second is that the activity of the crust underlying China as determined by the structural position of our nation's land mass is deeply marked by the outer manifestations of heat fields. All of these shall be discussed in detail separately in corresponding chapters of this collection.

2. The Present Situation and Task in Geothermal Research in China

Viewing the situation in general, the level of our nation's geothermal studies is relatively low. This is mainly reflected by the following two aspects: First, geothermal work has not yet been launched on a wide scale in the various departments of production units. In many areas, there is a blank in geothermal studies. General geothermal surveys of a mass nature began only in the 1970s in our nation. At the time, active campaigns by Comrade Li Siguang (2621 0934 0342) resulted in a wave of enthusiasm in geothermal resources survey of mass character. Beijing, Tianjing, Xian and other large cities sought out underground hot water for heating and as heat sources for agricultural and industrial use. At the same time, surveying of resources was conducted for the establishment of geothermal power stations at Fengshun in Guangdong, Huilai in Hebei, and Taiyuan in Shandong. At Fengshun and Huilai, experimental geothermal power stations have been built in 1971 and 1974 respectively. At present, surveying of resources of a large power geothermal power station is being conducted in the Yangbajing in Xizhang. But progress in surveying and exploration of geothermal resources on a nationwide basis is still not fast enough and the search for heat is limited to those places where there is heat, i.e., the work is limited to those places where surface heat has manifested itself and work has not been launched in other places on a wide scale. In the recent year, the problem of damage by high temperatures and heat in mines has become more and more outstanding as the depth of mining for minerals and coal conducted by each of the mines of the coal industry, metallurgical industry and the chemical industry increases. Because of this, many mines began to measure geothermal temperatures and began work in the prevention of damage by heat. But in the work of conducting geological surveys for newly developed mines, the work in measuring geothermal temperatures is still insufficient. Geothermal temperature data needed in designing the mines have not been obtained. Second, fundamental theoretical studies in geothermics such as measuring heat currents of the earth, studying the thermal physical properties of rocks (heat conductivity, specific heat, and rate of thermal diffusion), the rate of radioactive heat generation, and estimation of temperatures at the deep parts of the crust have only just begun. Other subjects such as tectonics of the crust and the upper mantle, simulative geothermal experiments indoors, and even studies of heat conditions inside the earth and theoretical computations of thermal history have not been touched on at present.

Because of this we believe our nation's geothermal studies at present have the following major tasks.

(1) Tightly Combine Production and Practice

Launch Geothermal Work With A Big Effort

The entire picture of the distribution of heat fields in our nation must be understood within a short time.

We should struggle to understand within a short time the entire picture of the distribution of heat fields in our nation to provide the theoretical foundations for practical uses in general surveys of geothermal resources, geothermal exploration and prevention of heat damage in mines.

Our nation's geothermal work of mass nature began only in the 1970s. Because of such a late start and although a batch of actual data has been compiled, the data are not sufficient whether in quantity and quality. At present, we only have surface heat maps, i.e., data on hot springs which reflect only a unilateral view of the distribution of heat fields in our nation. The emergence of hot springs on the earth's surface requires definite geological and structural conditions. The heat fields manifested by the hot springs are also limited by these geological and structural conditions. On the other hand, actual geothermal work has shown that often at places where there are no surface heat manifestations, there may possibly be a temperature field of even higher underground temperatures. Because of this, the whole picture of the distribution of heat fields in our nation must first be understood and this understanding is urgently needed in achieving our goals, whether it is in the development of geothermal energy, the utilization of geothermal energy, the prevention of heat damage or in the prediction of both "advantages" and "disadvantages," and this work can only be effectively done by mobilizing the masses to fight a people's war in the study of geothermics. Up to the present, the geological industry, the mining industry and the metallurgical industry have already done a lot of work. The petrochemical department has also conducted measurements of geothermal temperatures at each major oil fields such as Daqing, Dagang, Shengli, Jianghan and Sichuan. As long as we raise our realization, strengthen leadership, unify planning, launch the work of measuring geothermal temperatures throughout the geological prospecting departments of each production unit and hasten the accumulation of actual data, it is entirely possible to gain an understanding of the entire picture of the distribution of heat fields in our nation within 3 to 5 years.

(2) On the Basis of Closely Uniting Production and Practice, Gradually Launch Fundamental Theoretical Studies of Geothermics

1. Begin from "the flow" to hasten the work of surveying and experimenting with the earth's heat flow

Everyone knows that the physical quantity which can completely characterize the heat fields of the earth's surface and illustrate the thermal conditions inside the earth is the earth's heat flow. Since the 1960s, each nation has placed a lot of emphasis on heat flow surveys. As of the end of 1975, the entire world had compiled 5417 heat flow data (8). From these data, a global heat field distribution map was drawn and it was used as the basis for a series of discussions on problems in geology, geophysics and geochemistry. Our nation's work in heat flow surveying began in 1958 during the years of the Great Leap Forward. Because the techniques of surveying thermal conductivity of rocks were not up to standard, reliable heat flow data were never obtained.

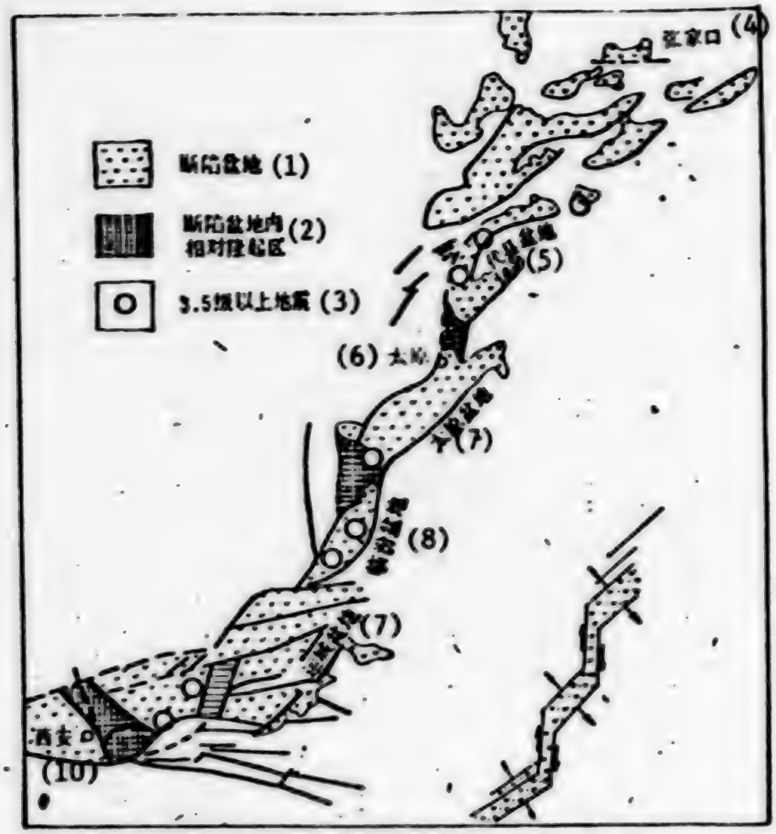

Figure 2. Downthrown basins in the Shanxi graben (by Zhang Wenyou et al., 1975)

Key:
- (1) downthrown basin
- (2) relative ridges in downthrown basins
- (3) earthquake of 3.5 scale or more
- (4) Zhangjiakou
- (5) Daixian Basin
- (6) Taiyuan
- (7) Taiyuan Basin
- (8) Lenfen Basin
- (9) Yuancheng Basin
- (10) Xian

In recent years, our group designed and assembled a "stable flat plate thermal conductometer" on our own and successfully used it to measure the thermal conductivity of samples of hard rocks. It was until this success that the first batch of 18 heat flow data were obtained from the north China region in our nation. This can only be said to be a good beginning. Since our nation's territory is so expansive and its geological structure is so varied and complex, the work of heat flow surveying must be hastened to rapidly accumulate a large batch of data so that a series of theoretical and practical questions can be explored. We believe heat flow surveying at the following regions should be taken as priorities in realizing the dual objectives of pursuing both practical application and theoretical research:

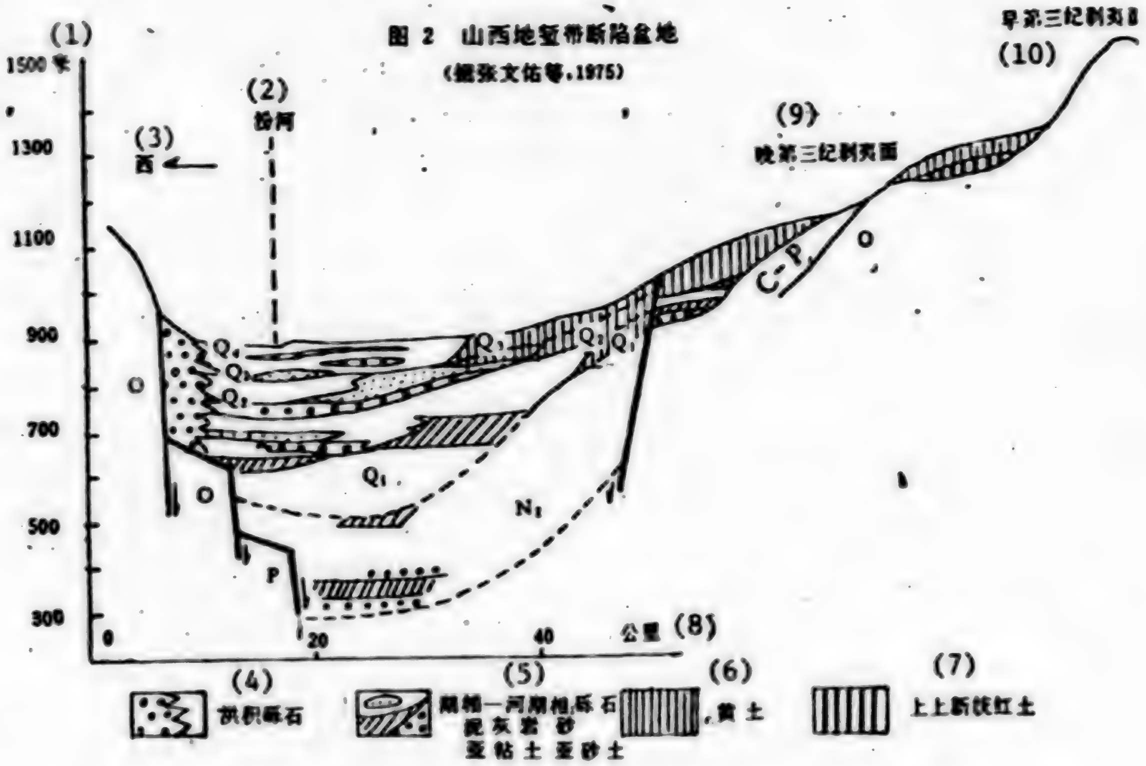

Diagram 3. Geological structure of the Taiyuan Downthrown Basin (General Introduction of China's Earthquakes and Geology, 1975)

Key:
- (1) meter
- (2) Fen River
- (3) West
- (4) Sedimentary gravel of floods
- (5) Lake facies-river and lake facies; gravel, marl sand, sub-clay, sub-sand
- (6) Yellow soil
- (7) Kilometer
- (8) Upper upper newly connected red soil
- (9) late tertiary stripped smooth surface
- (10) Early tertiary stripped smooth surface

(1) The Tan-Lu Fault of the east and the South-North Tectonic Belt of the west should be taken into particular consideration since these are large active belts along the borders of blocks. The former has already been discussed above. It is manifested by the distribution of heat fields on the earth's surface but reliable heat flow data of the actual fault have not yet been

obtained. Analysis of the South-North Tectonic Belt according to its surface hot springs, magma activity, tectonic activity and earthquake activity indicates it may very likely be a high temperature and high heat flow belt. It must be realized that geothermal temperature conditions of each section of a fault are not entirely the same. For example, along the section of the Tan-Lu fault from Fangzi in Shandong to Shuyang in Jiangsu, geothermal temperatures appear in a low-high-low-high pattern. The geothermal temperature gradient at the Fangzi Coal Mine is generally 2°C/100 meters. To the south, the Yinan Gold Mine has a high geothermal temperature gradient to 4.58°C/100 meters. Further south at Linyi, the geothermal temperature gradient of the tertiary downthrown basin in Shuyang east of Xuzhou rises again to 4.28°C/100 meters. According to research results obtained by comrade Zhang Wenyou et al (3,4) and from the viewpoint of mechanics, the forms of movement of each section along a large fault are not entirely the same. Often, one section is characterized mainly by shearing and another section is characterized by lateral displacement or by compression. Occurrence of these two movements may alternate. This can be easily understood in geothermal terms. Such heat carrying bodies as magma and hot liquid substances of displaced sections can easily surge up along channels, giving off high geothermal temperatures and producing a high geothermal temperature gradient. In sheared sections or compressed sections, relatively speaking, heat carrying bodies do not easily surge upward, and thus low geothermal temperatures and low geothermal temperature gradients occur. The movements in the Tan-Lu Fault since the mesozoic and the neozoic have mainly been either shearing-displacement or shearing-compression. Whether the pattern of low-high-low-high geothermal temperatures observed above along that particular fault is related to the different forms of movements of each section is worth further in depth study.

(2) Priority should be given to the study of heat flow of the neozoic graben downthrown basin such as the series of downthrown basins along the Shanxi graben (Diagram 2). Everyone knows that graben is a rift valley where the crust has split open and has been displaced. Midocean ridges are contemporary rift valleys. Famous large continental rifts are the Rheingraben, the Great Rift Valley of East Africa and the Great Rift Valley of Baikal. All of these regions have registered a high heat flow (> 2 microcalorie/centimer^2·second), and their geothermal temperatures and geothermal temperature gradient are also high. The thickness of the crust of the rift valleys is measurably thin (20 to 35 kilometers). The position of the low speed upper mantle, low resistance layer or partially molten plastic sphere is raised very high, lying directly underneath the crust or bulging upward and penetrating the crust. All of these form the deep geological background of the occurrence of high geothermal temperatures and high heat flows in rift valleys. At present, the deep geological background of the Shanxi Graben is still not clearly understood. But viewed from its geological structure, the many neozoic downthrown basins along the Shanxi Graben, such as the Datong Basin, the Daixian Basin, Xinding Basin, Taiyuan Basin, Linfen Basin and Yuncheng Basin began to form in the tertiary and gradually settled downward, and a thick layer of neozoic sedimentation was built up. For example, the neozoic sedimentation of the Datong Basin and Yuncheng Basin is 3000 meters thick and the sedimentation

of the quaternary of the Taiyuan Basin is about 700 meters thick (Diagram 3). The thermal conductivity of the loose or semicolloidal neozoic sedimentation is very poor (thermal conductivity 2-3 millicalorie/centimer.second .decree), as if there is an enormously thick cap of heat insulation and heat separation layer preventing the heat coming from the deeper parts from escaping. The above mentioned downthrown basins are all situated in sections of sawtooth shaped displaced faults. Therefore the Shanxi Graben may very possibly be a high temperature and high heat flow belt.

(3) Priority should be given to the study of heat flow of active ancient blocks such as the North China block. Judging from the period of formation of the base, two of our nation's blocks are the most ancient: the Hebei-Shadong Block. Their isotopic geological age is about 2.5 billion years (Recently, our institute discovered metamorphic rocks of lithofacies of metamorphic granules dating back 3.64 billion years in the Taipingzhai region of Qianan in Hebei province), and they are our nation's most ancient continental crust. Compared to similar archaeozoic structures of the world's ancient shields as Canada, Australia and South Africa, these ages are relatively small, but the degree of metamorphosis of the rocks is high. This may indicate that during the period of formation of our nation's most ancient continental crust mentioned above, the crust was thin, the geothermal temperature was high and the geothermal temperature gradient was high. Thus, a lot of field and laboratory work in many fields such as petrology, isotope geothemistry combined with high temperature and high pressure experiments must be done to revive ancient geothermal conditions during the period of formation of the earth's crust. This question possesses great theoretical value in explaining the formation, evolution and development of our nation's continental crust. On the other hand, the Hebei-Shandong Block to the east which has been affected even more by the active tectonic belt of the Pacific has since the neozoic become violently "activated" and has manifested obvious differential movements within the inner part of the block. There is frequent magmatic activity and earthquake activity is high. The geothermal manifestation is characterized by nonuniformity of heat conditions at the top part of the upper mantle and the deep parts of the crust due to a higher heat flow background (average-1.5 microcalorie/centimeter^2·second). This may also indicate the difference in the activity between the crust and the upper mantle. According to existing data on geoelectromagnetic measurements of depths, the depth of the low speed and low resistance layer of the upper mantle in the inner part of the Hebei-Shandong Block is not uniform. The layer may be as deep 80-90 kilometers or as shallow as 40-50 kilometers. Its temperature conditions are the same as its deep parts. The other two blocks that make up the North China block are the Taihang block and the Hiaoliao block. The age of their crystalline base is between 1.8-2.5 billion years, belonging to the early proterozoic era. Their tectonic activity has increased in strength since the nesozoic, especially the former. The Shanxi Graben mentioned previously is a rift valley which has developed on the foundation of that ancient block during the neozoic era. The four big blocks mentioned above, the Yangzi block and the Tarim block which have the early and middle proterozoic crystalline base (1-1.8 billion years) make up the main body of China's continental crust. Undoubtedly, a clear understanding of the present distribution of heat fields on these ancient blocks and reestablishing

a picture of ancient heat fields in different stages of development in geological history are extremely significant in theoretical and in practical terms to an understanding of the origin, development and evolution of our nation's continental crust as well as the formation and the pattern of concentration and enrichment of various minerals including geothermal resources.

(4) Priority should be given to the study of the mesozoic and neozoic folds and orogens. It can be seen from Diagram 1 that a series of paleozoic, mesozoic and neozoic fold orogens have developed among the ancient blocks and along their outer borders, such as the Tianshan-Hingshan orogen, the Kunlun-Qin, Qi-Dabieshan orogen, Longmenshan-Hengduanshan-Laoiashan orogen, Nadanhada Mountain Range orogen, the Himalayan orogen and the Taiwan orogen. According to research results of recent years (4, 67), these orogens are very likely the borders of ancient plates or ancient blocks during the various periods of geological history since the late proterozoic. They may have opened and closed many times in response to the activity of different tectonic stress fields. It is not difficult to imagine that many such tectonic changes have produced a great affect upon the distribution of heat fields. Geothermal studies indicate the effects of more ancient tectonic movements are less easy to recognize. We can only obtain a general idea from the traces left in the rock media while the violent effects of tectonic movements since the mesozoic and neozoic upon present-day heat fields are vividly displayed before us. Therefore, geothermal studies of these regions should be intensified.

(5) Priority should be given to the study of oceanic regions. It has been mentioned in the above that our nation's continental crust and especially the eastern regions have been greatly affected by the Pacific tectonic activity belt since the mesozoic. But knowledge about the geological structure and the various geophysical fields such as the gravitational field and the magnetic field including the heat field of our nation's eastern oceanic regions is unclear. This makes it difficult to make profound explorations of the actual effects of the Pacific tectonic activity belt on the continental crust. On the other hand, our nation's broad eastern oceanic region may very possibly be a region rich in various useful minerals, especially petroleum and natural gas and a region where these are concentrated. Everyone knows that geothermal conditions greatly affect the course of formation of oil and natural gas, their transportation and their development. For example, the crude oil of our nation's Daqing oil field has a high content of wax and a high viscosity. Recovery of the oil is possible without difficulty only because of high geothermal temperatures. Recently some one has speculated that in the process of formation of petroleum in the Daqing oil field, the rapid conversion, accumulation and enrichment of organic matter are closely related to the high geothermal temperatures of the mesozoic source basin. It can thus be seen that whether in theory or practice, oceanic heat flow surveys need to be developed with more haste.

2. Trace the "source" by the "flow" to understand the structure of the crust and upper mantle of our nation and understand the temperature conditions at the deep parts of the crust

Surveying and measurement of the earth's heat flow is the first step in theoretical geothermal studies. But we must not linger at this step. We must understand the conditions of the heat source by tracing "the source" by the "flow." At present, everyone seems to agree that generation of heat by the decay of radioactive elements is the main source of internal heat of earth, and radioactive elements are concentrated within a depth of a dozen or so kilometers in the uppermost part of the crust. Accordingly, some people in the latter part of the 1960s divided the measured values of heat flow on the earth's surface into two parts. One part originates from the layer in which radioactive elements are concentrated. The remaining part originates from the lower parts of the crust and the upper mantle. They proposed a model of dual heat structure of the crust and the upper mantle, and made logical estimations of the temperatures of the deep parts of the crust. Based on this, they explored a series of important theoretical and practical questions in earth sciences, such as the driving force of the movements of plates; heat convection of the mangle; the origin, development and evolution of the source of magma in the upper mantle; geothermal indicators of crustal activity; changes in the high temperature belts of the crust during the years of geological history. At present, work in these aspects is continuously being carried out more and more profoundly.

We have also taken samples at 18 heat flow surveying stations in the North China region and measured the content of radioactive U, Th, ^{40}K, determined the rates of heat generation of each rock layer, and combined the results with actual cross sectional studies of different layers of the crust to estimate the temperatures at the deep parts of the crust, but the work has just been started and there are many problems waiting for us to delve into more deeply.

3. Launch indoor simulative experiments to reproduce the results obtained from field observation

Simulative experiments frequently used in geothermal studies can be divided into two types, physical simulation and mathematical simulation. Physical simulation utilizes similar physical fields (such as the electrical field) to simulate actual distribution of heat fields in the field or the process of geothermal action. Mathematical simulation utilizes mathematical equations (such as Laplace's equation of heat conductivity) to obtain the desired results directly from given boundary and initial conditions. Physical simulation is more directly observable and more real but requires an entire set of experimental facilities and equipment. The time for preparation of the experiment is also longer and the initial and boundary conditions cannot be changed easily. Mathematical simulations are generally performed by computer. Computations are performed quickly and it is easy to change the boundary or initial conditions. An entire set of results under similar conditions can be obtained. Recently, we used actual data on the conditions of geothermal temperatures and geological structure of the Pingdingshan mining region in Henan and fed them into a computer to compute a mathematical simulation. The condition of high geothermal tempeatures in the mining region caused by differences in heat conductivity of the rocks and the raising of the base observed in the field was clearly reproduced. A quantitative evaluation was also given. This was helpful in forecasting geothermal temperatures of the deep parts of the mining region. The shortcoming of mathematical simulation is its various conditional limitations (such as difficulty in solving the equations, insufficient capacity of the computer etc) which often oversimplify complex situations or processes, thus affecting the experimental results to a certain extent. Because of this, physical simulation and mathematical simulation should be joined together so that the advantages of one can supplement the other's shortcomings, benefiting both.

(3) Perfect the Means of Surveying, Introduce New Techniques and New Methods, Hasten the Work in Geothermal Studies

Looking back at the history of our nation's work in geothermal research, we see that the rapidity of its development is determined to a large extent upon the perfection of the means of surveying and the use of new techniques and new methods. Take the geothermal temperature measuring device as an example, the earliest device used was the common thermometer. It gradually developed into the maximum thermometer, the resistance thermometer and today's semiconductor heat sensitive resistance well thermometer and the quartz crystal frequency meter to measure temperature. Each improvement brought about a step forward in geothermal research work. But viewing it as a whole, the means and equipment of geothermal exploration are still backward. New techniques and new methods have not been widely used. For this, we must quickly catch up with the times so that geothermal work can be hastened.

1. Perfecting existing means of surveying

This includes three aspects: One includes instruments and equipment for measuring the earth's temperature. The second includes facilities to survey and test physical properties of heat in rocks. The third includes equipment for measuring the content of radioactive elements in rocks.

(1) Equipment and instruments for measuring the earth's temperature: At present, instruments to measure the earth's temperature used by each unit are not standardized. They include everything from the ordinary mercury thermometer to semiconductor heat sensitive resistance well thermometer. In the past, coal mining, metallurgical, petrochemical and geological departments all used the Russian made resistance thermoeter or the well thermometer for measuring earth's temperatures in holes. This instrument uses copper wires as the heat sensitive component. Its precision is poor (± 1°C). Its operation is not convenient and it cannot satisfy the need of geothermal research work. After 1970, some scientific research and production departments gradually used the semiconductor heat sensitive resistance thermometer. Our group assembled a "semiconductor heat sensitive well thermometer" with a precision of within 0.1°C. Use by the coal mining and metallurgical industries showed good results but its degree of precision still needs to be elevated and the instrument itself requires further improvements. At present, every nation is using the quartz crystal frequency meter for temperature measurements in surveying heat flow with a precision of within 0.001°C. It is necessary

equipment for theoretical geothermal studies. Our group and fraternal units are jointly developing such equipment.

Most of the equipment for oceanic temperature measurements use heat sensitive resistors as the temperature sensitive component. Several (generally three) heat sensitive resistors are installed inside a steel pipe of 1.5 to 5 meters long to form the "probe needle" for measuring temperature. The "probe needle" penetrates the soft and loose sedimentary substances at the bottom of the sea by its own weight and records the temperature values of each heat sensitive resistor. The geothermal temperature gradient is thus calculated from the data. Diagram 4 illustrates the principles of oceanic temperature measuring equipment.

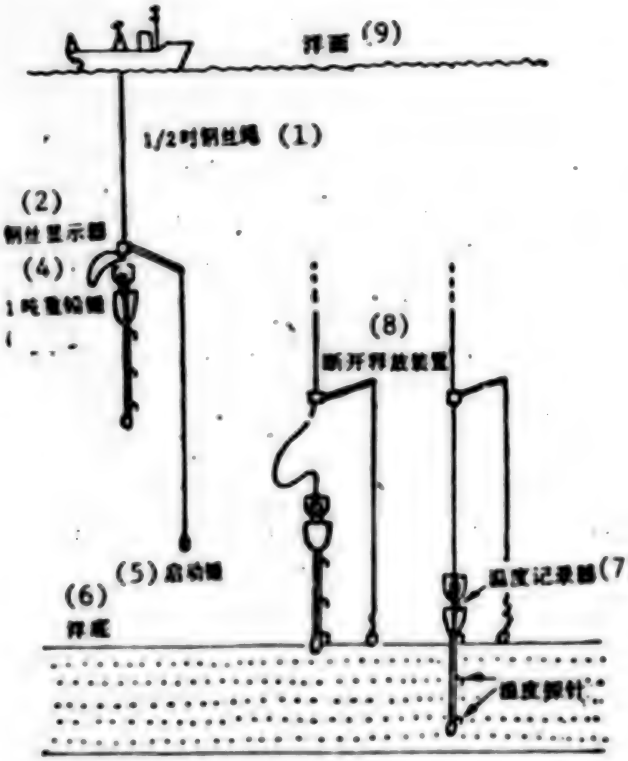

Figure 4. Illustrative drawing of the principles of an oceanic temperature probe

Key:
- (1) 1/2 inch steel cable
- (2) steel cable monitor (display)
- (3) 1 ton plummet
- (4) release mechanism
- (5) starting hammer
- (6) ocean floor
- (7) temperature probe needle
- (8) temperature recorder
- (9) ocean surface

(2) Equipment for surveying and testing physical properties of heat in rocks: Our group designed and assembled a "stable flat plate thermal conductomere" with a precision of 10 percent. This satisfies the need of theoretical thermal research. But at present it can only be used to measure hard rock samples, while often only mesozoic and neozoic loose or semicolloidal rock samples can be obtained from the large numbers of holes drilled in our nation's plains, especially holes drilled in oil fields. Contemporary oceanic sedimentation is even looser. Therefore a breakthrough must be made in the technique of measuring heat conductivity of loose and semicolloidal sedimentary samples so that a large amount of heat flow data in plains and in coastal waters can be obtained. Heat conductivity of rocks can be measured by the "stable method," the "unstable method," and the method of "positional measurement" which is used in mines or drilled holes. These are not further explained separately here. In addition, as the work gradually becomes more profound, consideration should be given to joining efforts with indoor high temperature and high pressure experiments to measure the heat conductivity of rocks under temperature and pressure conditions of the deep parts of the crust (such as 10,000 bar and 800°C near the Mohorovicic discontinuity.)

Some other frequently used parameters of thermal physical properties of rocks are: specific heat, heat capacity and rate of heat diffusion. The rate of diffusion is a necessary parameters in forecasting temperature of natural gas in the deep parts of wells and calculating the effects of temperature reductions. Generally, it is indirectly calculated from the thermal conductivity, specific heat and density of rocks. Specific heat of rocks can be measured by classical methods or the differential heat analyzer. Heat capacity is numerically equal to the product of specific heat and density.

(3) Equipment for measuring the content of radioactive elements in rocks. U and Th can be measured by the energy spectrum or chemical analysis. ^{40}K is computed by conversion of the total amount of K measured by the flame photometer or the atomic absorption spectrum. The rate of heat generation of the rocks can be calculated from the content of U, Th and ^{40}K in the rock samples.

2. Utilizing new techniques and new methods of geothermal exploration

The mainly refer to new techniques and new methods of geophysical exploration, methods of geochemistry such as the use of the silicon geothermal meter and the Na/K thermometric scale which have already been widely applied in the general survey and exploration of geothermal fields and will not be explained here.

(1) Infrared exploration technique: Everyone knows that the near infrared spectrum (8-14 μ) of the commonly used spectrum and the far infrared spectrum (8-14 μ) are sensitive to temperatures and they are a kind of important tools in geothermal exploration. Some famous regions of abnormal geothermal activity in the world such as the geothermal regions of Yellow Stone Park in the United States, Japan, New Zealand, Iceland and Mexico can be studied by using surface and aerial infrared photography with good results. Recently, our nation's geological department conducted aerial infrared surveys in the southeastern coastal areas of Guangdong and Fujian. It is also an effective way

to explore abnormal geothermal temperature fields of volcanized mineral deposits, oil and natural gas fields. Infrared exploration techniques are fast and can be used to explore large areas and have many advantages. By avoiding some interference factors such as topography, plants and growth which cover the surfaces and bodies of water on the earth's surfaces, especially the effects of external heat from sun rays, the infrared technique can become an effective means for general surveys of geothermal resources over large areas and a means to acquire an understanding of the general view of the distribution of heat fields.

(2) Satellite remote surveying and remote sensing techniques.

This is a comprehensive technique which emerged during the mid-1960s. Satellites fly high (about 1000 kilometers), their field of vision is wide and they can be used for global surveying. By installing infrared surveying equipment in a satellite, observation of even larger areas is possible and measurements can be taken continuously and the activity of change of the heat fields can be grasped. In addition, and within a short time, it can even be described as in a flash of a moment, images of large areas can be "captured," and theoretically this can eliminate the effects of external heat from sun rays, and the earth's surface heat fields can be more precisely shown.

(3) Geolectromagnetic surveying: This is a method developed in the 1960's to use the different cycles of the natural magnetic field to quantitatively understand the electrical strata of the media of deep layers underground to derive temperature conditions. It can determine the low resistance layer of low speed and high electrical conductivity of the upper mantle, i.e., the position of the partially molten zone of the plastic sphere, and provide the deep geological background of surface heat fields. This will benefit geothermal research greatly. If it can be used in combination with the method of conversion waves of natural earthquakes, better results can be obtained.

(4) Detection of microseism. In regions of abnormal geothermal activity, the surge of heated water and air causes extremely slight tremors or quakes. High precision microseismographs can pinpoint the channels by which heated water surges upward and the area of distribution of such heated water. Practice shows this can also serve as an effective means of conducting general surveys and exploration of geothermal fields.

(5) Other geophysical methods of exploration, such as electrical methods of exploration, and exploration of gravitational forces and magnetic forces are already being widely used in geothermal investigations and the results are good.

3. Outlook

Geothermics is a young science that is developing prosperously. It is full of life. Our nation is a nation with extremely rich geothermal resources and also possesses many unique geological characteristics. Along with the development of socialist construction, a series of topics in geothermal studies have been brought out. But our nation's geothermal work began rather late and the foundation is rather weak. The masses must be mobilized to fight a people's war. Geothermal work must be launched widely in the various departments of production units so that the entire picture of the distribution of heat fields in our nation can be understood within a short period. Theoretical geothermal research must be closely united with actual production. At present, emphasis should be placed on evaluation of geothermal resources, development and utilization of geothermal energy and prevention of heat damage in mines. Actual situations must be delved into deeply to solve the problems. Measurements of the earth's heat flow and other theoretical work must be gradually launched upon this basis. Geothermal research related to the topics of some important fundamental theories of earth science (such as the formation of the Qinghai-Xizang Plateau and its evolution; geological structure of the China Sea) must be given priority consideration and breakthroughs in the key points must be made.

In general, each geothermal research project must take into consideration the far and the near, the mainstream and the secondary. They must be done according to actual situations. The most important and the less important must be differentiated. The wisdom and efforts of everyone must be pooled to carry them out step by step, gradually and according to plan. We believe, as long as we follow firmly the revolutionary scientific research line of Chairman Mao and march forward under the leadership of Chairman Hua and the leadership of the Party Central, we will surely be able to push our nation's geothermal research work to a new height within the near future and realize the great strategic goal of surpassing the world's advanced levels.

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9296
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AIRCRAFT ENGINE GROUND TESTING PLATFORM PRODUCED

Beijing RENMIN RIBAO in Chinese 3 Feb 80 p 2

[Report: "China Produces Ground Testing Platform for Aircraft Engine--Persisting in the Policy of Self-reliance and Learning from Foreign Experience"]

[Text] A new-type of ground testing platform for aircraft engines designed and built by China has received official approval for its use following over 2 years of efforts. The results of an evaluation of this newly structured, sophisticated and relatively advanced aircraft engine testing device showed that its performance is normal and its characteristics are excellent. Its development was accomplished 1 year sooner than if its complete set of equipment had been ordered from abroad. The decision to produce it in China has provided an opportunity for training a number of technicians in this field and has greatly reduced the amount earmarked for investment in this project. The cost for the construction of its scaffold and servicing system accounted for only 3.6 percent of its foreign counterpart, thus saving the state a large amount of foreign exchange reserves. This success has received commendation from the leading comrades on the Party Central Committee.

This ground platform for testing the airworthiness of the aircraft engines is a highly automatic and technologically sophisticated device. As far as the testing and checking of aircraft engines are concerned, this platform is more precise and accurate than all its existing domestic counterparts.

At the beginning, some people suggested ordering it from abroad on the grounds that our own technical force might not be able to produce it in a short time. This suggestion gave rise to a question: should we design and build it by ourselves or order it from abroad? After conscientiously analyzing various opinions, comrades of the Fourth Planning and Design Research Institute of the Third Ministry of Machine-Building Industry, concluded that if we decided to purchase it from abroad, it would cost the state a large amount of foreign exchange reserves, and the platform might not be delivered on schedule as required; if we decided to build it by ourselves, there were many difficulties as well as advantages. Since the 1950's, we have acquired basic technical know-how and experience in designing and building nearly 100 similar platforms and have mastered related advanced foreign technology. After weighing the advantages and disadvantages, they confidently suggested: "Domestic resources should be mobilized to carry out this project; it is necessary to trust our own technical force." This correct proposal was immediately approved by the responsible comrades of the Third Ministry of Machine-Building Industry who decided to let its Fourth Planning and Design Research Institute design the projected platform and the Xian Hongqi Machinery Plant build and install it.

After receiving this instruction, the comrades of the institute pledged to work hard and come up with an ideal design of the platform. While drawing a design, they emancipated their minds, combined the learning with inventions, and absorbed the most useful experiences in designing similar projects at home and abroad. In close coordination with the Hongqi Machinery Plant, they basically completed the drawing of that design in the first year of the development of the project. Later, advanced technology was applied in the construction of a new-type scaffold suspended from the ceiling, which is simple in structural design but capable of scanning a wide area with great accuracy. It is also easy to install, operate, maintain and repair. The sound-proof system was built with locally available acoustical panels with tiny holes, acoustic boards and other noise-absorbing materials.

In the construction of a hangar housing the platform, the substitution of a girder-type structure for the originally designed concrete cement structure had not only cut down the expenses but also shortened the time for the construction of the entire project. The result was a ground testing platform for aircraft engines unique to China.

Units responsible for the construction of the hangar and for the manufacturing and installation of equipment had persisted in working diligently in a spirit of cooperation. The Hongqi Machinery Plant was responsible for building 12 servicing systems and over 50 parts for the ground testing platform. After overcoming a series of technical difficulties, it eventually produced those key sophisticated parts whose standards had proved higher than what their designers had expected, and had installed them without delay with the support of its fraternal units.

A successful test and adjustment of the ground testing platform for aircraft engines is crucial to its future successful operation and is a guarantee for our future success in the mass production of aircraft engines. Our 60-year-old aircraft engine expert comrade Wu Daguan [0702 1129 6034] persisted in personally supervising and directing the trial-run of the platform. Under his guidance, technicians and workers carefully examined and scrutinized every system and calibrated every instrument in the platform. We had also received assistance from foreign experts in testing out this platform.

9574
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APPLIED SCIENCES

FRENCH DELEGATION VIEWS 'REBIRTH' OF PRC SCIENCE

Paris LE MONDE in French 9 Jan 80 pp 15-16

[Text] Chinese science: a fragile rebirth. Headed by the secretary of state in charge of research, Pierre Aigrain, a delegation of about a dozen officials from research organizations, including a newspaperman who had been invited to join them, journeyed to China at the beginning of December; they visited about 20 research institutes or similar establishments in Peking, Canton and Shanghai. The object of this journey, returning the 1978 visit to France of deputy prime minister in charge of scientific affairs, Fang Yi, was to find new subjects for scientific cooperation between France and China, and to establish or reinforce contacts. This is not always easy as there is no distinct correlation between French and Chinese organizations. Thus, the normal counterpart for our CNRS (National Center for Scientific Research) would be the Chinese Academy of Science, but the latter, contrary to our CNRS, does not work with social sciences, which has its own academy; on the other hand it administers applied research institutes (mechanical engineering, computer technology, civil engineering) for which CNRS is not the best spokesman.

This visit permitted us to sign a basic agreement for geological cooperation (LE MONDE dated 16-17 Dec), and to outline others. It also made it possible for us to get a brief view of the present state of Chinese science.

What level has their science reached? The director of the geological institute in Peking (a former associate of Teilhard de Chardin) gives us preliminary outline: "We suffered two catastrophes: the "gang of four" and an earthquake. The context breaks up the apparent equilibrium of this sentence, and indicates very clearly that for our interlocutor the 1976 disaster that cracked the walls of the institute was the least of his worries.

We hear the same bell ringing everywhere. The decade which separates the beginning of the cultural revolution from the elimination of the "gang of four", will remain a painful ordeal, a period of great trouble for Chinese researchers. Some institutes were purely and simply closed and the personnel were recycling themselves by getting in touch with the peasant masses.

And if not all laboratories died, all were stricken from having submitted to inapplicable directives at best and, at worst, from having become scientifically retrogressive.

A consequence of this traumatism is visible immediately: a generation is missing. Many of the laboratories are managed by sexagenarians, or older persons, in general trained abroad, long before "liberation," a term used to designate Mao Zedong's victory and the foundation of the PRC. Behind them there are only rare intermediate cadres, and a whole pleiad of young researchers whose enthusiasm cannot compensate for experience.

A small revival of scientific activity began in 1972, and it was only after Mao's death that science and technology became, along with agriculture, industry and national defense, one of the four "modernizations" towards which one billion Chinese are marching, to hear them tell it, as one man. Reality is evidently much more complex. One needs only observe cyclists' behavior in the streets of Peking, or Canton, to figure out that with respect to individualism China has nothing to learn from France. Other signs demonstrate that between official policies and those that which is really followed there is more than a little difference, but apart from these reservations, the effort consecrated to scientific research is undeniable. In 1979 the laboratories received 5.9 billion yuan, or 15 billion francs, which is 5.2 percent of the total national budget.

Being a researcher in China is, however, not an ideal situation. A young researcher earns 36 yuan per month, he will double his salary at the end of 15 or 20 years. A doctor starts at 45 yuan; a few laboratory directors get salaries comparable to the old regime, reaching 300 yuan. Thirty-six yuan represents 100 francs, but the comparison makes hardly any sense; housing costs 5 yuan per month, the universal blue suit costs less than 10 yuan, but a bicycle is worth 250. The most significant, however, is the comparison between researcher and engineer. To prefer the productive sector to the laboratory will lead to a large bonus which will be added to the salary and could bring the monthly remuneration up to 70 yuan.

Nor are working conditions very cheery. Especially in Shanghai, in addition to the laboratories being without any type of heat, the equipment is often discouragingly poor. Furthermore, each institute must make most of the equipment it uses; purchases from abroad seem to be the exception and this complaint will be heard constantly: "We could do so much more if we had adequate materiel."

As much as possible, equipment is replaced by manpower, teams are numerous, with an apparent highly specialized division of labor. And the researchers' enthusiasm, which appears undeniable, allows them sometimes to work wonders.

What is most memorable about these visits? They surely do not offer a comprehensive view, but some conclusions can be made. There are some good laboratories, but for the most part they have not had enough time, many having been built from scratch since 1977, nor the means to attain an international level.

A complete recapitulation of these visits would not be of great interest. We will just try to point out below some of the best or most salient points. Chinese science is undergoing a renaissance. Will this be a birth or an abortion? The former requires political stability and continuity in an effort which China has never known until now. Various signs incline one towards pessimism. If some of the eastern cities have reached the turning point, the leaders of some of the provinces in the interior seem to be living in the period of the cultural revolution. When the deputy prime minister, Deng Xiaoping, addressing the French delegation, expressed the wish that France aid China not only in the scientific field but on the economic and even the military level, without proposing anything in exchange except the promise of world peace that the development of China would mean, it sounds somewhat like an admission of weakness.

Medicine: Needles and Skin Grafts

The Rui-Jin hospital in Shanghai is situated in the old French land grant. Many of the administrators were educated there and speak French. Even where some of the real old-timers are concerned, and even if the French, like others, have left behind some not-too-good memories in Shanghai, one notices an admiration of things French in their conversation which seems to arise from the past and is beyond what courtesy requires.

The hospital is attached to a medical training institute. In this connection there are 30 professors, 150 lecturers in charge of teaching 400 students. There are also 200 student nurses. The total number of hospital personnel amounts to 1,800, of which 350 are doctors. There are 1,180 beds covering 20 clinical services: medicine, surgery, gynecology, pediatrics, traumatology, orthopedics.

But what distinguishes the Rui-Jin Hospital from the others is its center for the treatment of serious burns. Dr. Shi Tsi-siang, is in charge of 160 staff personnel who take care of 30 service beds.

About 20 years ago the burn center became known all over the world when it saved a metal worker who had been burned over 89 percent of his body, 23 percent third degree burns. Since then the center has set other records, the last in 1977 when it saved a patient who had sustained third degree burns over 94 percent of her body.

One would expect a very luxurious installation, sealed-off rooms and unprecedented precautions. Nothing of the kind. The equipment is just as rudimentary as it is in the rest of the hospital. There are only two doors between the passageway and the beds. And groups of visitors wearing nothing more than white blouses and provided with gauze masks are allowed to approach and touch patients who are burnt over large surfaces and are lying there prostrate and sometimes unconscious. True, a flow of laminal air isolated a relatively sterile micro-atmosphere around the patient. But this is a quite ridiculous barrier in view of the risks of generalized infection.

The real protection is found elsewhere. A temporary skin graft was performed on the patients who have no skin left. This skin is taken from cadavers, often from the elderly. A device was built for this sampling operation. The skin is preserved at the temperature of liquid nitrogen, it is cooled very slowly, one degree per minute, until it reaches preserving temperature. On the contrary, when it is needed for grafting it is heated very rapidly in a physiological serum bath.

Treatment of a badly burnt patient begins by removing all the scabs from the burnt skin which are open doors to infection. Then the skin of the cadaver, in which 1 square centimeter holes have been punctured, is grafted. In the middle of these, small pieces of skin taken from parts which had not been burned are grafted; the skull is usually protected by hair and the skin grows in very quickly which permits frequent removal of skin for grafting. These sieve grafts initiate growth of the skin, progressively replacing the cadaver's skin which peels off.

Acupuncture

Another important research field for Chinese doctors is that of their old-fashioned acupuncture. It has been modernized in the last 10 years. An electro-acupuncture has been developed, where an electrical impulses at a rate of 2 or 3 per second are sent into the needle and replace the traditional stimulation obtained by turning the needles. This was a very meticulous operation and difficult to carry out during the hours which a long operation could entail as, for instance, in the total or partial removal of the stomach. However, there is no single rule. While Rui-Jin hospital uses electro-acupuncture, other establishments prefer to use the traditional method. Anyway, it is still not known what the needles stimulate (the acupuncture pricks often follow the course of a nerve, but the needle does not touch the nerve). The discovery in the past few years that enkelphalines, the "morphines of the brain", have made it possible to establish a hypothesis: the needles probably induce the production of enkephalines. Some characteristics of anesthesia by acupuncture are clearly explained by the secretion of some substance. In fact, anesthesia does not appear until about 15 minutes after the beginning of the treatment, then it diminishes gradually for a period of one to two hours after the needles are removed. There is also a more direct proof, if the circulatory systems of two dogs are joined together, the second dog can be anesthesized by implanting the needles in the body of the first. The blood has therefore transmitted something. Does it mean that it could be enkephalines? And how do the needles release their [pain-killing] product? The mystery remains.

In spite of this technique, which the Chinese doctors have mastered, and of which they have solved the major problem, conservation of the skin at low temperature, failures are still very numerous and difficulties still exist, particularly in the matter of feeding patients suffering from massive burns. The lack of supervisory equipment is also a handicap, although here again the inexhaustible Chinese human potential is called upon: each patient is constantly observed by one or several persons who are ready to render assistance. And all the modern and traditional pharmaceutical resources are insufficient to prevent the risk of septicemia.

As pragmatists, the doctors have temporarily given up trying to understand everything, but they use acupuncture every time they can, which is to say, frequently, nevertheless keeping an anesthetic at hand (during the course of an operation it sometimes happens that the patient feels pain, which was not foreseen). It is surprising for a westerner to see a patient undergoing a meniscus operation chatting with two acupuncturists while the surgeon is working on his knee. And the operation completed, to sit down on the operating table, flex and straighten his leg and shake the hands of the five people, not one more, who participated in the operation. Five people and the patient who was operated on, in a bare room, with minimum equipment where the surgeon himself performs the final bandaging after he has finished plying the scalpel; a primitive operation and intentionally so; surgical teams are being trained who will go to the villages and will perform operations every day, sometimes Caesarean sections, in any handy building, using acupuncture [as the anesthetic].

Biology: Insulin and Insects

In March 1978 a national conference on the sciences adopted an 8-year program defining the main topics of Chinese research. They favor eight sectors: the first is agriculture; the Chinese population is still more than 90 percent rural. The last is genetic engineering. Biology is thus presented at both extremities of the program, in both its most applied and most fundamental aspects.

However, it does not seem to be all that well off. Physics laboratories appear to have relatively sophisticated equipment. Moreover, many institutes have been in operation for only a very short time; some are long-standing but suffered a long eclipse during the cultural revolution. Nevertheless quality research is carried out in some laboratories. For instance, the Shanghai biochemistry institute has studied insulin thoroughly, or rather the various insulins, synthesizing analogous forms, producing more and more effective insulin from snake venom, by extracting active fragments and finally a pentapeptide which extends the hormonal activity of insulin and which could have interesting consequences for the treatment of diabetes, a disease very prevalent in China.

Cancer of the Liver

In general, the institute studies fundamental biochemistry (structure of nucleic acids and proteins, study of membranes, genetic manipulation, theories, etc.), but possible applications are never lost sight of and they determine the choice. This has resulted in an early diagnosis method for cancer of the liver which earned an international prize for institute researchers. Valuable work in animal physiology was performed in the zoological institute in Peking, a large organization which employs 600 people and deals with many varied subjects: taxonomy, ecology, nutrition...

They are also conducting interesting studies on communication between insects. These could have important applications if they could result in focusing on methods to bring about the concentration of insects in a predetermined place where they could easily be destroyed.

Physics: Lasers and Crystals

What is the major difference between the large laser intended for research on thermonuclear fusion at the optics and precision mechanics institute in Shanghai, and the large laser which the directorate of military applications of the AEC (Atomic Energy Commission) has installed for the same purpose at the Limeil-Brevannes (Val-de-Marne) center? To a newspaperman's eye an answer is necessary: in Shanghai I was invited to take photographs!

There are other differences: the power level reached (100 billion watts) is notably inferior to what is being achieved in France and other Western countries and the installation of the large six-armed laser, especially, is very makeshift. No rigid or precise optical benches, sketchy precautions against dust. All luxury is absent in this large room. But the neodymium blocks of glass which amplify light are apparently faultless. And the photographs of the microscopic ball crushed by the [laser's] luminous pulse show very symmetrical distortions. The installation is crude but it functions and neutrons have been produced which is a sign that the burn-up and the temperatures obtained have made it possible to initiate nuclear reactions.

Another large laser is being manufactured, a carbon dioxide gas laser, the first one uses a yag (garnet aluminum and yytrium) and neodymium glass. And in the lower power ranges, the Chinese institute is building practically all types of lasers imaginable, which function with visible, ultra-violet and infrared light; there are continuous lasers and pulse lasers with pulse durations varying from some tens of picoseconds to a few milliseconds (2); there are doubler frequencies, accordable lasers... in short the panoply is complete.

The institute is divided into 14 laboratories and four workshops responsible for manufacturing the essential experimental equipment for the laboratories. Like other laboratories this one functions almost completely independently: the four workshops employ 500 people and manufacture all the lenses, mirrors, glass discs and mechanical assemblies required for the experiments. A few rare electronic devices come from other institutes or factories. In addition, the workshop furnishes optical equipment to other research organizations.

(1) It is believed that a quarter of Chinese research is under military control, and strictly secret. It is not unlikely that China has more powerful installations at its disposal.

(2) A picosecond is a billionth of a millisecond, or 10^{-12} seconds.

A Lot of People

Including the workshops, the institute employs a total of 1,500 people, of which 400 are university graduates; here again one finds the major characteristic of all Chinese laboratories: jobs for many people, actually many more than would be found in a comparable French laboratory. In a general manner, men replace machines; numerous people are needed to register and analyze measurements, to permanently regulate the alinement of optical apparatus on the course of the large power lasers.

However, some laboratories seem to be much better equipped than the average. This is the case at the ceramics institute, still in Shanghai. It is a relatively small institute where 400 scientists and technicians are working. Physics, chemistry, technology and numerous nonmetallic materials are being studied: synthetic crystals with electro-optical, acousto-optical and ferroelectrical properties; quartz and artificial diamonds, varied types of glass, particularly for low-loss optical fibers and all types of ceramics.

This research bears especially on the conditions which must be respected in order to obtain transparent ceramics; the institute researchers have obtained PLZT (lead-lanthanum-zirconium-titanium) ceramics of great transparency. Finally, the institute has in its possession a small office specialized in the nondestructive dating of old porcelain; the sale of Chinese antiquities is severely regulated by the authorities who want to preserve their precious heritage.

But what amazes the visitor is the number and variety of the appliances: oscilloscopes "made in China," mass spectrographs, ionic probes, various types of recorders: they are close to European standards. Why is this laboratory so particularly well equipped? No doubt the obviously useful character of the research conducted here, which does not prevent it from being basic, kept it from experiencing too much trouble during the cultural revolution. The institute, created in 1960, beginning with a small group of researchers, seems to have developed in the usual manner and has more or less escaped the brutal changes of direction which disorganized Chinese research. Along the halls one perhaps can find an appliance imported from Japan, but that is the exception. Everything else is manufactured in China and some things are manufactured on the spot.

Like the others, the ceramic institute has a pilot-workshop and three technical laboratories specializing in electronics, chemical analysis and structural analysis. But the large appliances come from the outside, perhaps from the scientific instruments factory in Peking. This factory, in fact, is a research laboratory for instruments, but oriented towards three sectors; electronics, microscopy, mass spectrometry and vacuum technology. It is responsible for the development of appliances, then with their manufacture, according to demand or in small numbers to equip other laboratories. It manufactures many types of electron microscopes, some associated with ionic probes or Raman; mass spectrometers; and molecular pumps. Construction is good, and the appliances perform well, but are not highly automated and not highly miniaturized. Moreover, the director of the factory recognizes these deficiencies. Man can replace the machine when it is on his level; he is helpless in anything which concerns micro-electronics and computer science.

But thanks to human effort, Chinese researchers compensate in part for their flagrant lack of a technological infrastructure.

Peking Synchrotron: A Symbol

The alluvial plain on which the city of Peking is situated abuts on a series of hills on the edge of the great Mongolian steppe, about 10 km from the "northern capital" (Beijing, which the French distorted to Peking).

It is in this neighborhood that HEPEC (High Energy Physics Experimental Center) will be situated, comprised of a group of laboratories built around a proton synchrotron; in 1985 it will transmit a force of 50 GeV (50 billion electron-volts) at 10^{13} protons per pulse. It will be made up of a pre-injector, a linear accelerator--both already built--of a first booster ring, and finally of the so-called synchrotron itself, a ring 430 meters in diameter.

The pre-injector is a source of negative hydrogen ions (one proton plus two electrons). These will be extracted by an output of 850 kilovolts and will enter into a small linear accelerator and upon emerging the energy of the ions will reach 0.09 GeV. They will then be "peeled off" when passing through a thin sheet of metal which will separate the electrons from the protons. The latter will penetrate into the booster, a ring 40 meters in diameter, where their energy will be raised to 2 GeV. They will then be extracted and directed towards the principal ring. It is planned to use some of the 2 GeV protons at a later date for low energy experiments. After passing into the final ring, the protons will be directed towards an experimental hall where they will create, by colliding with several targets, many beams of secondary particles destined for experiments in particle physics. A second experimental hall will be built after 1985 reserved for experiments with neutrino beams.

The decision to build HEPEC was made in November 1977, and it was anticipated that it would be operating in 1982. But last March all scientific policies were reconsidered for reasons of economy and a sudden brake was imposed. The installation opening was postponed to 1985.

This synchrotron is symbolic, for two reasons. On the one hand, it is a tool of the purest fundamental research, the most lacking in practical applications, even if its construction will provide a certain know-how to the researchers which can be used for other purposes. It demonstrates that China has decided to show itself in all fields of scientific research, even in those which would seem to be a luxury for a country where the leaders make no effort to hide their country's poverty. On the other hand it is also a measure of China's scientific backwardness. In 1985 China will have provided itself with a synchrotron which will hardly surpass the one that the CERN (European Organization for Nuclear Research) put into service in Geneva at the end of 1959. This delay is not being concealed, but it would seem that they want to catch up; on the same site a place is already reserved for a synchrotron 3 km in diameter.

7993
CSO: 4200

PARTICLE PHYSICS CONFERENCE HELD IN CONGHUA

Hong Kong WEN WEI PO in Chinese 5 Jan 80 p 2

[4 January news report by WEN WEI PO reported Chen Nan [7115 0589]: "Particle Physics Symposium Convenes in Conghua Today"]

[Text] From January 5 through 13, China's first largest symposium on particle physics research will be held in the Conghua [1783 0553] Hot Spring Hotel. One hundred and fifty physicists from China, Hong Kong and abroad attended the meeting. The well-known physicist and Nobel Prize winner Yang Zhenning [2799 2182 1380] and Li Zhengdao [2621 2398 6670] also participated as members of the meeting's advisory committee.

At the "1980 Guangzhou Particle Physics Symposium" were high energy physics theorists from the Chinese Academy of Sciences and related colleges and universities in the country who delivered 60 academic theses. Besides, some 30 to 40 theses were also disclosed at the symposium by scholars from Western Europe, the United States, Southeast Asia and Hong Kong.

An advisory committee composed of scientists from both at home and abroad was organized and consisted of the following members: Wang Ganchang [3769 3227 2490], Zhu Yuanhong [2612 0337 3163], Zhang Wenyu [1728 2429 5940], Li Zhengdao [2621 2398 6670], Yang Zhenning [2799 2182 1380], Zhou Peiyuan [0719 1014 3293], Hu Ning [5170 1380], Qian Sanqiang [6929 0005 1730] and Tan Huanwu [6223 2719 2976].

The scholars who attended the symposium arrived on January 4 and were welcomed by Professor Qian Sanqiang, leading member of the organizing committee. Qian Sanqiang said that Hua Guofeng and other state leaders attached great importance to the symposium.

9119
CSO: 4008

STATE MEDICAL GENERAL ADMINISTRATIVE BUREAU DRAFTS REALISTIC RESEARCH PLAN

Beijing GUANGMING RIBAO in Chinese 4 Jan 80 p 2

[Text] For better rationalization of the drafting of a scientific research plan and better effective function of the limited scientific research funds, the State Medical General Administrative Bureau recently held a scientific research planning conference in Beijing. They adopted peer review and counseling by specialists on the scientific research plan drafting of the medicine of both western and Chinese, and medical instruments from the whole nation, and the scientific research plans of the provinces, cities and self-governing districts for 1980. They proceeded with serious investigation and revision and made the scientific research tasks more concentrated, the goals clearer, and the important points more distinct.

1. Clearing the direction of the scientific research and strengthening of the character of the planning: There has never been a nationally unified plan for the scientific research of Chinese medical materials in the past, but only an emphasis on the importing of new strains. For these precious drug materials, some districts imported new strains disregarding conditions, and created a waste of manpower, materials and money. Simultaneously, no one investigated some tasks which are urgently needed to be solved. In this conference, the comrades engaging in research of Chinese drugs unified their recognition of the task, mainly to develop authentic drug materials for the research of Chinese drugs taking advantage of the geographic convenience. Based on this foundation, the concerned tasks were divided into 11 major classifications. The important points were then sought in each classification and listed into the plan. The lack of planning in the past in research of Chinese drug materials was changed.

2. Avoiding the duplication and submitting some tasks of research which are urgently needed: For example, at the counseling, it was found that Chekiang Province did the identical investigation in 1978 to which the Soochow Medical Instrument Factory was assigned to make an experimental production of an automatic photometer in the original plan. This duplication is unnecessary; then based on the specialty of the Soochow Medical Instrument Factory, it was arranged to make an investigative production of the funduscopic camera, which is urgently needed in hospitals. Originally, more than 10 provinces reported the tasks of investigation on

raising and hibernation of the biological drug "Pai-Hua Snake." By the understanding of the facts that some provinces had already found means to solve these two problems, it is clear that the research of urgent need is the artificial propagation of the "Pai-Hua Snake" in the future. Through counseling, it was decided to put emphasis on the artificial propagation of the "Pai-Hua Snake," in the future. In this way, the research tasks were deepened a step further.

3. Strengthening of weak points and considering of overall development: In the past, the pharmaceutical industry put main force into the research of production of the drug materials and neglected the research of drug quality and quantity, type of drug products, and fundamental theory. In this conference they proceeded to adjust the occupying proportions of every item in the plan and appropriately increased the tasks in the research of quality and quantity, type of drug products, and fundamental theory.

4. Better organizing of scientific research power and listing of tasks of great difficulty into the plan: The research of the chemical structure of drugs and their therapeutic effect relationship and the biological effectiveness is very important. This is a relatively difficult task of the fundamental theory, which a single unit cannot manage. For breaking through this barrier, the comrades in the industry, universities, and colleges who are engaging in this research, organized collaboration teams, through investigative conferences, and listed this task into the plan.

During the process of investigation of revising the draft plan, the State Medical General Administrative Bureau clearly submitted that the original plan drafted by the General Bureau could be supplemented, revised or overthrown, if there was any place recognized as inappropriate, with sufficient numerical evidence and ample reason. Comrades from all places seriously and carefully did overall balance and adjustment of the draft plan, by examining item by item from practical realistic points. Every item upon examination showed excellence or disqualification, and was then supplemented or eliminated; applied research and fundamental theoretical research both obtained appropriate consideration; sufficiently gave the leading role to the advanced areas, and also drew attention to the assistance of the organization of the areas which have less advantageous conditions. The comrades who attended the conference felt: in this way, to enact the scientific research plan, the democracy is well exalted and enhanced. Concentration of precise opinions, and complying with the practical situation will benefit the development of the scientific research work.

9474
CSO: 4008

PROBLEMS IN ADMINISTRATION OF BAREFOOT DOCTORS OUTLINED

Shanghai JIEFANG RIBAO in Chinese 16 Nov 79 p 1

[Article by reporter Zheng Zhiyuan [1728 1807 6678]: "Let Barefoot Doctors Return to Their 'Home Town'"]

[Text] According to the investigation, there are more than 9500 barefoot doctors in the suburban areas of this city [Shanghai]. Recently 500 to 600 barefoot doctors are requesting leave from their duties for various reasons every year. Many of them asked to get into a commune factory to serve as workers. Furthermore, a considerable number of them do not feel at ease in their work. If this trend does not change it will seriously affect the medical services among the members of the people's communes in the suburban areas and endanger the cooperative medical care program in the rural areas. It is imperative that the leaders at various levels and affiliates units show concern over this problem, so as to get the barefoot doctors to return to their hometown and pursue the work free of worry.

Why would the barefoot doctors like to leave and try to serve as factory workers? According to what we gathered from the city public health department and comrades concerned, the reason is that they are in a situation in which "no one is in charge" and they are virtually on their own.

Some of the barefoot doctors stated that they are personnel under "three no-managements": the commune does not have a special management official; the Department of Health is unable to administrate; the production brigade generally is unwilling to manage, and just requires that the barefoot doctors can treat the patients and do nothing to cause an accident which might cost a person's life. Many places put emphasis on running small factories and paid less attention to the cooperative medical care program. Cases of eliminating public health stations and medicinal herb farms and of building small factories have frequently been reported. The "three no-managements" pose many problems. For example, the barefoot doctors in most of the suburban areas of Shanghai did not organize the study of politics, and no one checked on the labor participation program. Some barefoot doctors committed mistakes on economic and livelihood problems because they did not attend study classes and have not taken part in labor for a long period of time. No one was in charge of the program for retraining and upgrading the barefoot doctors. Most of the counties in the suburban areas did not have training centers nor uniform teaching materials. Many barefoot doctors are not knowledgeable in epidemiology and could not effectively prevent epidemic diseases, thus causing a high rate of epidemic diseases in the rural areas around Shanghai in recent years. Some areas had a severe labor shortage due to an increase in the number of patients during the busy farming season.

The grain and cotton crops almost in their hands could not be harvested in time, thus seriously affecting agricultural production. According to the statistics, only around 10 percent of more than 9500 barefoot doctors in the city meets the intermediate standards for health care skills. Furthermore, due to a lack of rational compensations and incentives, many barefoot doctors do not actively make night house calls and do not try to upgrade their medical skills, improve their service attitude, and strengthen the administration of the cooperative medical care programs. Of course, the cooperative medical care program generally would be running in the black in its expenditures if it was managed conscientiously. However, at the present time, in many areas, there is disorder in the management of the cooperative medical care program. Some brigades have not been keeping accounts for years and the sales of pharmaceuticals by the health departments of some of the brigades are not clear. Several barefoot doctors divide the amount of pharmaceuticals from a purchase and individually dispense the drugs when they treat patients. The use of medicinal herbs has considerably decreased in recent years in the cooperative medical care program of Shanghai. Overspending in the cooperative medical care budget has become quite serious. According to statistics, among more than 2800 production brigades in suburban Shanghai, 41 percent had exceeded the cooperative medical care budget last year and it is expected to reach around 50 percent this year. Most of the brigades overspent several thousand yuan and the most several tens of thousand yuan. To improve the above cited situation, the Office of Education and Health and the Office of Agriculture of the Shanghai Revolutional Committee last year issued two reports on "Strengthening the Public Health in the Rural Areas." The concerned departments of the City Health Bureau have done much work in this respect. However, the results have not been encouraging.

Why is it so difficult to improve this situation? The reason lies in the bad way of thinking on the part of many cadres. Because the "gang of four" had highly praised and used "barefoot doctors", the barefoot doctors no longer wanted to perfect this line of work. In fact, this way of thinking is wrong. We should not break the tea cup for the reason that it was used by the "gang of four." Now, every advanced unit in the cooperative medical care program in suburban Shanghai is earnestly treating the internal wounds left by the "gang of four." At the Xinnong Brigade the Fengwei Commune in Jinshan County, the cooperative medical care program registered a monetary surplus every year by strengthening the financial management and by widely using Chinese medicinal herbs and the members of the communes now report fully their expense accounts when they see the doctors. Within the city, more than 20 units, including the Fengxian Zhuangxing Commune, Loutang

Commune in Jiading County, and Xinchang Commune in Nanhui County already tried operating joint commune-brigade and commune-run cooperative medical care program, expanding the scope of reporting medical expense accounts by the commune members and achieving the goal that "one gets sick, ten thousand people give help." The commune members praised the "joint commune-brigade" and commune-run cooperative medical care programs as "farmers' great labor insurance." The practice of many years proved that people's communes need the barefoot doctors. The consolidation and development of the rural cooperative medical care programs constitute a major problem involving whether or not the agricultural modernization program can be realized. All quarters concerned especially the leading cadres at all levels, must strive to become enthusiasts in support of training and fostering barefoot doctors and the rural cooperative medical care program.

9474-R
CSO: 4008

LIFE SCIENCES

USE OF LITHIUM CARBONATE TO TREAT MANIC-DEPRESSIVE PATIENTS PROVES EFFECTIVE

Beijing ZHONGHUA SHENJING JINGSHENKE ZAZHI [CHINESE JOURNAL OF NEUROLOGY AND PSYCHIATRY] in Chinese Vol 12 No 4, Dec 79 pp 204-206

[Article by Wang Zuxin [3769 4371 6082], Han Yonghua [7281 3057 5478], and Fang Mingzhao [2455 2494 2507] of the Psychiatry Teaching and Research Group of the Third Subsidiary Hospital of the Beijing Medical College]

[Text] In 1949, Gade (foreign medical reference (Book on Psychosis) 1:13, 1974) first used lithium carbonate to treat psychosis. It has now been proven that it is effective in treating manic-depressive psychosis. It also has a preventive effect against duo-phase manic-depressive psychosis. Our department has used lithium carbonate to treat 27 cases of manic-depressive psychosis since 1975. The treatment of 19 cases whose clinical information is more complete is reported below:

1. General Information:

Eleven patients were males and eight were females. Their ages ranged from 15 to 51 years. Durations of their disease varied from 2 months to 37 years. Fourteen cases were cyclic manic-depressive (duo-phase), and five cases were single phase mania. Before treatment, 18 patients manifested slight manic states, one patient manifested anxiety and depressive states. Fourteen patients were hospitalized. Five cases were out-patients. Within a 2-month period, an average of 13 cases had a history of illness of from 36 days to 120 days.

2. Method of Treatment:

Our department used lithium carbonate produced by a certain nonferrous smeltery in Xinjing. Purity of lithium carbonate was greater than 99 percent. Impurities contained 0.015 of barium, 0.007 of iron, and 0.03-0.05 of heavy metallic sodium. Each tablet contained 200 milligrams of lithium carbonate.

All patients were treated with lithium carbonate for the first time. Prior to such treatment, many of the patients were treated ineffectively by artificial hibernation, insulin and various psychotherapeutic drugs. After being treated with lithium carbonate, conditions of two-thirds of the patients (12/19) reached a level of being cured within one month.

To reduce irritation of the stomach and the intestines by lithium carbonate and to prevent poisoning, the medicine was ingested by the patients after meals with boiled salt water and the patients were encouraged to drink a certain amount of boiled salt water. The dosage began from 600 milligrams a day and increased daily (to between 1,600 and 2,000 milligrams a day) for a week. After the patients' conditions improved, this dosage was maintained for 7 to 10 days, and then, it was reduced to 1/2 to 1/3 (600 to 1,000 milligrams a day) and maintained at this level. Of the 19 cases, one patient was given a daily dose of 2,200 milligrams continuously for one week. About half of the patients (10/19) were given a daily dose of between 600 and 1,400 milligrams. These dosages also produced satisfactory results.

Patients of ten cases discussed in this article were given lithium carbonate simultaneously with chlorpromazine of between 100 and 200 milligrams a day (Each individual was given a combined dose of 300 milligrams a day. In two cases, the patients were given three separate intramuscular injections of the full amount of mixed wintermine solution within the first week after treatment by lithium carbonate began.) Because of fluctuations in the condition of the illness during the treatment in one case, an additional 20 milligrams per day of fluopiperidine alcohol and 100 milligrams per day of dolophine were administered. Some patients were given 4 days of combined medication and others were given 6 days of such medication. All patients during the course of treatment by lithium carbonate were subjected to definite periodic physical examination, examination of the nervous system, blood tests, tests of urination patterns, gluco-propyl ammonia lyase and musk cloud tests, phenol red test, checks of nonprotein nitrogen, tests of the binding strength of carbon dioxide and electrocardiographic examinations. During treatment, blood pressure, pulse and temperature were taken daily. Every 2 weeks, blood, gluco-propyl ammonia lyase and musk cloud tests were performed again and urination patterns were reexamined. Every 2 to 4 weeks, another electrocardiogram was given. During the first week of treatment, the content of lithium in the blood was measured twice. Afterwards, it was measured again every week or every 2 weeks. When necessary, on-the-spot reexaminations were conducted according to dosage and the patient's reaction.

We examined the concentration of lithium in the blood of 14 patients many times during the entire course of treatment. Some patients who used this medicine to maintain effectiveness of the treatment were also regularly reexamined without exception. One patient who was continuously given 2,200 milligrams/day of lithium carbonate was examined 2 weeks later and the concentration of lithium in the blood was 1.86 milligrams equivalent/liter (mEq/L). The rest of the patients were given a daily dosage of below 2,000 milligrams. Their concentration of lithium in the blood did not surpass 1.5 mEq/L. Table 1 shows the relationship between the concentration of lithium in the blood and the daily dosage.

Table 1 The Relationship Between the Concentration of Lithium in the Blood and the Daily Dosage

	<1,000 mg	1,200~ 1,400 mg	1,600~ 2,000 mg
(1) 血锂值范围 (mEq/L)	0.28~0.93	0.63~1.03	0.65~1.36
(2) 平均血锂值 (mEq/L)	0.58	0.80	0.82

Key:

1. Range of content of lithium in the blood (mEq/L)
2. Average content of lithium in the blood (mEq/L)

We compared the concentrations of lithium in the blood resulting from different periods of application and different doses for 14 cases. Dosage and concentration of lithium in the blood of 54 man-times are shown in Table 2.

3. Analysis of Effects:

1. Criteria for judging the effectiveness of treatment:

(1) Completely cured: Clinical symptoms completely disappeared and consciousness of self was completely restored; (2) Visibly effective: Clinical symptoms basically disappeared but self consciousness was incomplete; (3) Improved: Clinical symptoms partially disappeared and self consciousness was incomplete; (4) Ineffective: Clinical symptoms did not change and patients did not manifest self consciousness.

Table 2 Relationship Between the Daily Dosage and Content of Lithium in the Blood of 54 Case-Times

(1) 血锂值 (mEq/L)	<1,000mg	1,200~ 1,400 mg	1,600~ 2,000 mg
<0.5	7	2	2
0.5~1.0	12	11	8
1.01~1.5	···	2	9
1.51~2.0	···	···	1
(2) 共 计	19	15	20

Key:

1. Content of lithium in the blood (mEq/L)
2. Total

2. Effectiveness: Thirteen cases were completely cured. Treatment of four cases was visibly effective. Treatment of two cases showed improvement in condition.

3. Analysis of clinical effectiveness: There was no remarkable difference ($P > 0.05$) between clinical effectiveness and the effects of age, history of the disease, and combinations of small doses of sedatives administered with lithium carbonate.

(1) Mutual relationship between effectiveness of the treatment and clinical effectiveness: Of 19 cases, 14 were duo-phase manic-depressive psychotic cases. Nine cases were cured. Of the five cases of single phase mania, four were cured. Comparison of these two groups showed $x = 0.001$, $P < 0.001$. Although statistical indications are remarkable, it cannot be concluded on this basis that the effectiveness in curing single phase mania is better than duo-phase manic-depressive psychosis because the number of single phase mania was too few.

(2) Relationship between the time of manifestation of effectiveness of the treatment and the daily dosage: Of the 19 cases, effectiveness of the treatment in 17 manifested itself in 4 to 20 days. On the average, varying degrees of effectiveness of the treatment were manifested in all patients after 9 days of treatment. At the time of manifestation of effectiveness of the treatment, the daily dosage of lithium carbonate was between 600 and 1,400 milligrams, an average of 745 milligrams a day. The effectiveness was manifested first by a reduction of excitement in physical motion and in speech followed by improvement in blunted emotions The sedative and hypnotic effects of this medicine were not obvious. Even when large doses were administered, the patients did not visibly show tiredness. Some patients had to be given small amounts of sedatives each night.

(3) Relationship between the time the patient was cured and daily dosage: Of the 17 cases in which the treatment was visibly effective, 13 were cured. The time in which the patients were cured was from 14 to 39 days after receiving treatment (six cases were cured after 14 to 20 days, seven cases were cured after 21 to 39 days). The average time when the patients were cured was 21 days after treatment. At the time the patients were cured, the highest daily dosage of lithium carbonate administered was between 800 and 2,200 milligrams, averaging 960 milligrams.

4. Side Effects:

Of the 19 patients discussed in this article, 15 suffered from various side effects at different times in the course of treatment by lithium. Almost all side effects occurred in the first 3 weeks of treatment. Frequently observed reactions were mainly symptoms of the intestinal tract and the nervous system. Symtoms of reactions of the intestinal tract were mainly nausea and lack of appetite, followed by thirst and constipation. In general, the conditions of the patients improved after these symptoms were treated directly and continued treatment by this medicine was not affected.

A few patients who vomited did not suffer such side effects anymore when the medication was ceased or when the dosage was reduced. Three patients manifested minor involuntary shaking of the hands 2 weeks before the medicine was administered (In one case, such minor shaking disappeared after 2 weeks). In another case, minor shaking continued for 6 weeks but disappeared gradually after the amount of medicine was reduced. In a third case, such shaking remained). Five patients showed reactions of the extra conoidal system of inability to sit quietly, heightened muscular tension and inability to speak clearly for 3 weeks during medication. These symtoms were directly treated and they disappeared. There were no patients who ceased treatment because of side effects. Reactions of the extra conoidal system may also be related to the simultaneous intake of anti-psychotic medicines. In 14 cases, gluco-propyl ammonia lyase and musk cloud tests and comparison studies were performed before, during and after treatment. In only two cases, the use of lithium carbonate for 40 days to 3 months combined with chlorpromazine of 100 to 250 milligrams per day brought about a rise in the amount of gluco-propyl ammonia lyase of between 100 and 200 units (in contrast to the normal 80 to 120 units). Twenty days after the use of chlorpromazine was stopped, the amount of gluco-propyl ammonia lyase returned to normal. Electrocardiographic comparisons were made in 15 cases. Among the 10 patients with normal electrocardiograms before treatment, one patient suffered from "right bundle branch heart block" after using lithium for a month (daily dosage at the time was 1,000 milligrams). At followup visits (daily dosage was 600 milligrams firm), his electrocardiogram showed similar patterns as before. The electrocardiograms of the remaining patients did not change. Before treatment, the electrocardiograms of five patients were abnormal: there were two cases of hallow palpitation and one case of arrhythmia, one case of high electrical voltage from the left ventricle, and one case of lengthened Q-T interval (0.35 seconds) and variation of T wave. These five patients were all given antipsychotic medication prior to treatment by lithium carbonate. After treatment by lithium carbonate, the electrocardiograms of four cases normalized. In the other case, the lengthened Q-T interval (0.35 seconds) and variations of the T wave remained. In recent years, Jiliam. A.G. et al (Am J Med 61:665, 1976) noticed that cardiovascular effects of lithium have been frequently seen, including flat or inverse reversable T wave followed by clotting in and blocking of the hallow atrium, myocarditis, lengthening of the P-Q interval and flattening of the S-T segment. However, the mechanism is unknown. Thus during the course of clinical treatment using lithium carbonate, definite periodic electrocardiographic examinations should be conducted. Comparative studies were made of the normality of the blood in 12 cases. In eight cases, the results of blood tests that were in the normal range before treatment were unchanged after treatment by lithium carbonate. In four cases, the white corpuscle count was high before treatment (12,000 to 20,000/cubic millimeter). Two of these cases showed a normal white corpuscle count after treatment by lithium and the white corpuscle count of the other two remained high. Comparative studies of urination patterns were conducted for 11 cases and no visible change was noted.

5. Question concerning the relationship between the level of lithium in the blood and the dosage of lithium carbonate used in treatment:

Observations of 14 cases indicated when the daily dose of lithium was below 2,000 milligrams, the amount of lithium in the blood generally was within the safe range (<1.5 mEqL). When the daily dose of lithium was greater than 2,000 milligrams, the content of lithium in the blood was high. There was one patient who was given a continuous dosage of lithium of 2,200 milligrams/day for 2 weeks, and the content of lithium in his blood was 1.86 mEq/L. But the content of lithium in the blood is easily affected by other conditions. For example, we observed that when the daily dose of lithium was below 1,000 milligrams, the content of lithium in the blood was between 0.28 and 0.93 mEq/L. When the daily dose of lithium was between 1,200 and 1,400 milligrams, the content of lithium in the blood was between 0.65 and 1.36 mEq/L. Through 54 case-times of measuring the content of lithium in the blood at different times and in different amounts of lithium carbonate treatment, it was determined that the content of lithium is basically directly proportional to the daily dose of lithium containing medication.

6. The question concerning safety and whether prolonged use of lithium carbonate can sustain the effectiveness of treatment:

After one year of followup visits, there was one patient out of the 19 who was still hospitalized. The remaining 18 cases showed a stabilization of conditions and a sustained effectiveness of treatment. There were no relapse cases and no other serious side effects were observed. Of course, further observations are needed since the time is still short.

Perliminary analysis of clinical data on treating 19 cases of manic-depressive psychosis indicates this medicine is highly effective, produces few side effects, and under strict control of dosage administered, the content of lithium in the blood remains within a safe range. If the relationship between the dosage of lithium carbonate and the concentration of lithium in the blood is to be determined, large numbers of clinical applications and more in-depth studies must be conducted before such determinations can be made.

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CHINA PUBLISHES NEW SCIENCE, TECHNOLOGY JOURNAL

'SCIENCE AND TECHNOLOGY REVIEW'

OW262350 Beijing XINHUA Domestic Service in Chinese 1720 GMT 25 Jan 80 OW

[Excerpts] Beijing, 25 Jan--Imbued with enthusiasm to make contributions to China's four modernizations, people of Chinese extraction and Overseas Chinese scholars and specialists living in the United States and other areas abroad have jointly issued a comprehensive science journal, SCIENCE AND TECHNOLOGY REVIEW monthly [KEJI DAOBAO 4430 2111 1418 1032]. The first issue of this journal has already been published. One hundred thousand copies of this issue are being sold at the XINHUA book stores in Beijing and other provinces, municipalities and autonomous regions as of 26 January; subscriptions for this journal will be accepted by the post offices in various localities. This Chinese-language journal is also on sale abroad.

Centering on various subjects for China's modernization, KEJI DAOBAO studies and introduces the experiences, lessons and conditions in modernization abroad, and seeks experience and methods for achieving modernization in the fields of economics, engineering, technology; natural sciences, social sciences, education and scientific research so as to borrow foreign experience to serve China's four modernizations and, at the same time, to promote scientific, technical and academic interchanges between China and foreign countries.

The publication of this journal is the first of its kind by overseas scholars. It reflects their friendship and warm feelings for China's socialist modernization and wins warm approval from the various units in science and technology, publication and distribution, as well as warm support from U.S. academic circles. Frank Press, adviser to the U.S. President on science and technology, has written a special message of greetings for the journal.

The major table of contents for this issue of KEJI DAOBAO is as follows:

"A Comparison of Economic System," written by Jiang Ziyi, professor of the Research Institute of the Georgia Institute of Technology, introducing the three major economic systems in the world: marketing economy, central planned economy and combined marketing and planned economy;

"From Scientific Management to Management Science," written by Chen Guozong, professor of Boston College, on management science, introducing developments in management science;

"An Actual Example of Regional Economic Planning: Tennessee's Miracle," written by Cheng Yuan, professor of the Department of Civil Engineering at Colorado State University, introducing the comprehensive plans, overall control and development of the Tennessee River basin in the United States and the successful experience in achieving modernization in this farming area, with the area of this river basin being equivalent to that of China's Huai River basin;

"Farming in Deserts and Drip Irrigation," written by Lo Huaitao, a specialist in hydrography, introducing drip irrigation, which is a new method of a high world standard for irrigation suitable for use in desert and semiarid areas;

"Technology for Prestressed Concrete," written by Professor Lin Tongyan, member of the U.S. Academy of Engineering Science and world-famous specialist on bridges and in structure engineering, introducing the technology of prestressed concrete, which is used for saving a large amount of rolled steel in the course of modernization;

"High Speed Drilling," written by Professor Wang Fengdan, adviser to the U.S. Department of Energy and director of the Research Institute of the Colorado School of Mining, introducing new technology in high-speed drilling suitable for use in mining and railway and urban construction;

"A Brand New X-ray Technology: C T," written by medical internist Wu Jinghui, introducing new technology that won the 1979 Nobel medical award;

"Trends in Aircraft Design," written by Professor Wu Jianmin, technical adviser of the U.S. Boeing Aircraft Company and chairman of the department of aerodynamics at the University of Tennessee, introducing the development and the current situation in this special technology of aircraft designing;

"Development in Data Communications," written by electronic engineer Zhu Yunchang, explaining the profound in simple terms and introducing in an all-round manner the use of computers;

"U.S. Scientific Research System," by Dr Huang E, introducing the U.S. scientific research system, its plans, the ratio among various funds, the geographical distribution of professionals, and other conditions;

"Interview of 1979 Nobel Prize Winners Professor (Wengapo) and Professor (Glaso), introducing their views on the development of science, ways of doing scholarly research, and the training of scientists and technicians;

An interview of a specialist in higher education, Dr (Kerr), and a number of articles on education introducing the development, renovation and current situation in U.S. higher education.

First Issue on Sale

Beijing XINHUA in English 1225 GMT 27 Jan 80 OW

[Text] Beijing, 27 Jan (XINHUA)--The first issue of SCIENCE AND TECHNOLOGY REVIEW--a monthly magazine in Chinese published by the Education and Science Society of the United States of America is now on sale in China. One hundred thousand copies of the first issue are being sold in 29 municipalities, provinces and autonomous regions.

In an effort to promote China's modernization and the exchanges in science and technology between China and other countries, the magazine is published jointly by American scientists and Overseas Chinese scholars.

The editorial board includes such internationally known scholars as Prof Chen-Ning Yang, physicist; Prof Shing-Shen Chern, mathematician; Prof Ven-te Chow, water resources expert; Prof Tumayen Lin, bridge and structures engineer; Prof Min-Chueh Chang, physiologist; Prof Chang-Yum Fan, astrophysicist; Prof Yuan-Cheng Fung, bioengineering scientist; Prof Ernest Kuh, electrical engineer; Prof Hsiao-Lan Kuo, meteorologist; Prof We-Ping Loh, Pathologist; Prof Yao-Tsu Wu, physicist in fluid mechanics; Prof Ching-Kung Yang, sociologist; and Prof Chia-Shun Yih, physicist in applied mechanics.

Editor-in-chief is geophysicist Ning Chien.

The magazine's main theme is to explore the courses and means of modernization. Particular attention is paid to management, science and economics. The 104 page magazine contains many pictures and charts. The front cover of the first issue is a photograph of Beijing taken by LANDSAT II orbiting over the city on March 30, 1975. Articles in this issue include "Economic Systems--a Comprehensive Overview (Japan, Yugoslavia, USSR) by Professor Tzu-i Chiang of the Georgia Institute of Technology; from "Scientific Management to Management Science" by Prof Gorden Chen of the University of Massachusetts; "The Tennessee Miracle" by Prof Yuan Chen of the State University of Colorado; "An Interview With the Nobel Laureates Wienberg and Glashow": and a number of other articles on technology, science, research and development and education.

Dr Frank Press, science and technology adviser to the President of the United States, wrote a message for the magazine. He said: "Exchanges of scientific knowledge are the principle tools through which proples and nations advance themselves. They hold the key [illegible] only to the understanding of nature but to working with her to meet human needs and to raise living standards through the process of technological development."

As the review is the first magazine published abroad to be widely circulated in China, it is given special attention by the decision makers and administrators of the state and provincial governments, enterprises, research and educational institutes as well as leading scientists and engineers.

CSO: 4008 END

SELECTIVE LIST OF JPRS SERIAL REPORTS

CHINA SERIAL REPORTS

CHINA REPORT: Agriculture
CHINA REPORT: Economic Affairs
CHINA REPORT: Plant and Installation Data
CHINA REPORT: Political, Sociological and Military Affairs
CHINA REPORT: RED FLAG*
CHINA REPORT: Science and Technology

WORLDWIDE SERIAL REPORTS

WORLDWIDE REPORT: Environmental Quality
WORLDWIDE REPORT: Epidemiology
WORLDWIDE REPORT: Law of the Sea
WORLDWIDE REPORT: Nuclear Development and Proliferation
WORLDWIDE REPORT: Telecommunications Policy, Research and Development

*Cover-to-cover

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